TRAINING MANUAL

Recent advances in marine fisheries and taxonomic research in India

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In-Plant Training, For College of Fisheries, Kawardha, Chhattisgarh

भाकृअनुप
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CMFRI

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Kerala, India

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In-Plant Training, For College of Fisheries, Kawardha, Chhattisgarh

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Diversity and exploitation status of Crustacean Fishery Resources in India

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India is blessed with long coastline of about 8118 km along the West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and Pondicherry along the east coast; along Gujarat, Maharashtra, Goa, Karnataka, Kerala along the west coast. India has 2.02 million sq.km exclusive economic zone area and 0.53 million sq.km continental shelf area, a potential source for marine fisheries.The rich continental shelf area, a good habitat for demmersal fishes as well as crustaceans such has penaeid prawns , non-penaeid prawns, crabs, lobsters and stomatopods. Mechanised trawler is the main gear operated in the continental area targeting crustacean resources, Though trawl net is operated for penaeid prawn, non penaeid prawns, crabs and stomatopods will be formed as by catch because all these resources habituate in the same fishing ground.

Crustacean resources

Crustacean resources comprises with penaeid prawns, non-penaeid prawns, crabs, lobsters and stomatopods. Total landings of crustacean resources, group wise and contribution of crustacean resources to total marine fish landings during 1996-2014 are shown in table, 1.

Total annual marine fish landings of India ranged from 2.29 to 3.93 million t with mean at 2.92 million t. Annual total crustacean resources ranged from 3.52 lakh t to 5.32 lakh t with mean at 4.45 lakh t, and its contribution to total marine fish landings ranged from 12.6 % to 18.9 % with mean at 15.2 %. The landings of penaeid prawns ranged from 1.71 lakh t to 2.67 lakh t with mean at 2.07 lakh t. Landings of non-penaeids ranged from 1.04 lakh t to 2.13 lakh t with mean at 1.54 lakh t. The catches for lobsters ranged from 1,201 t to 2,787 t with mean at 1,860 t. Crab landings ranged from 27,538 t to 55,695 t with mean at 42,675 t. Stomatopod catches varied from 21,187 t to 92,611t with mean at 39,433 t. On an average penaeid prawns contributed 7.1%, non-penaeid prawns 5.3 %, crabs 1.5%, stomatopods 1.3 % and lobsters 0.1 % (Fig.1).

Trends in crustacean resource landings, group wise, are shown in fig.2. Increasing trend was observed in total crustacean resources during the 19 years period. Both penaeids and non – penaeids have shown increasing trends. A marginal increasing trend was observed in crab landings. Though lobster catches have shown decreasing trend, its contribution to total crustacean resources was very less (0.1%). Despite increasing trends exhibited by penaeids, non penaeids, crabs, stomatopods have shown decreasing trend because of competing in the same fishing ground with penaeids.

East Coast

State wise crustacean resources (t) and crustacean resources contribution from east coast to total crustacean landings of India are shown in table, 2.

The contribution of crustacean resources from the east coast is 27.0 % to total crustacean landings. Tamil Nadu contributed highest (8.3 %) followed by Andhra Pradesh (6.8 %), West Bengal (6.1%), Orissa (5.5%) and Pondicherry (0.3 %) (Fig. 3).

Tamil Nadu contributed 30.9 % to the total crustacean resources of the east coast, followed by Andhra Pradesh (25.0%), West Bengal (22.7%), Orissa (20.4%) and Pondicherry (1.1%). (Fig. 4).

West Coast

State wise crustacean resources (t) and crustacean resources contribution from west coast to total crustacean landings of India are shown in table, 3.

West coast contributed 72.9 % of total crustacean resources of India. Gujarat contributed high (28.3 %) followed by Maharastra (23.9 %), Kerala (13.2 %), Karnataka (6.3 %) and Goa (1.3 %) (Fig. 6).

Along the west coast Gujarat contributed high (38.9%), followed by Maharastra (33.7%), Keral (18.1%), Karnataka (8.6%) and Goa (1.7%) (Fig. 5).

Commercially important species

Commercially important of penaeids, non penaeids, crabs, lobsters, state wise, are shown in table, 4.

Table, 1.Group wise crustacean landings (t) along the Indian Coast during 1996-2014.

year	Penaeids	Non penaeids	Lobst ers	crabs	Stomat opods	Total crustacea ns	Total fish landings	%
1996	187792	104462	2631	28908	72342	396135	**2380842**	16.6
1997	208542	153636	2787	44820	92611	502396	**2692409**	18.7
1998	214678	173950	2619	34152	72603	498002	**2635670**	18.9
1999	174384	147961	2094	27538	49918	401895	**2401706**	16.7
2000	204277	151515	2431	48253	46141	452617	**2652928**	17.1
2001	176448	145232	1389	29739	34944	387752	**2292703**	16.9
2002	203801	137714	2573	36049	48553	428690	**2589645**	16.6
2003	214780	137229	1233	41988	37341	432571	**2587095**	16.7

2004	171641	116231	1371	40900	32071	362214	**2538105**	14.3
2005	172099	121107	1201	37182	21187	352776	**2295490**	15.4
2006	172460	170787	1551	51067	30551	426416	**2710988**	15.7
2007	195599	138983	1523	40420	25163	401688	**2888461**	13.9
2008	213327	187173	1974	55695	30500	488669	**3207205**	15.2
2009	245159	168415	1872	47897	27379	490722	**3205453**	15.3
2010	260181	126997	1720	52243	30150	471291	**3346687**	14.1
2011	267932	187061	1761	50847	25250	532851	**3820207**	13.9
2012	252300	164951	1640	52473	27613	498977	**3937752**	12.7
2013	196942	213474	1410	44586	20650	477062	**3781868**	12.6
2014	205602	183405	1568	46061	24266	460902	**3592853**	12.8
Mean	207260	154225	1860	42675	39433	445454	2924109	15.2
%	7.1	5.3	0.1	1.5	1.3	15.2		

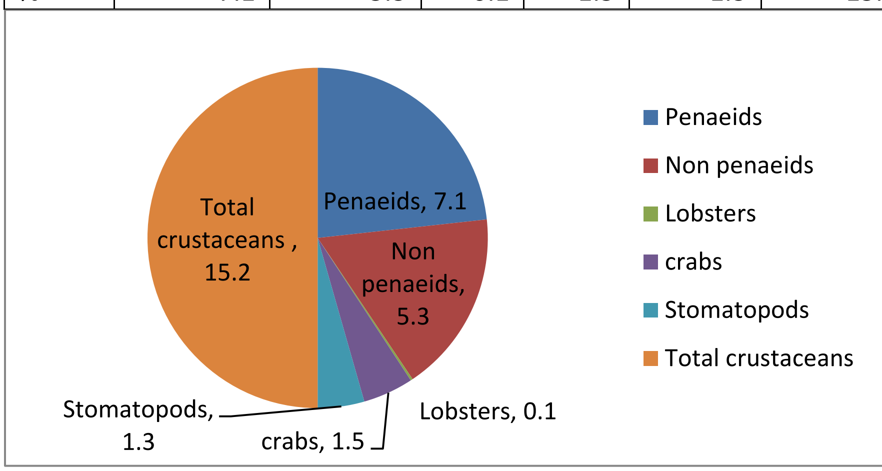

Fig.1. Mean contribution of crustacean resources, group wise, to total marine fish landings for the nineteen years period (1996-2014).

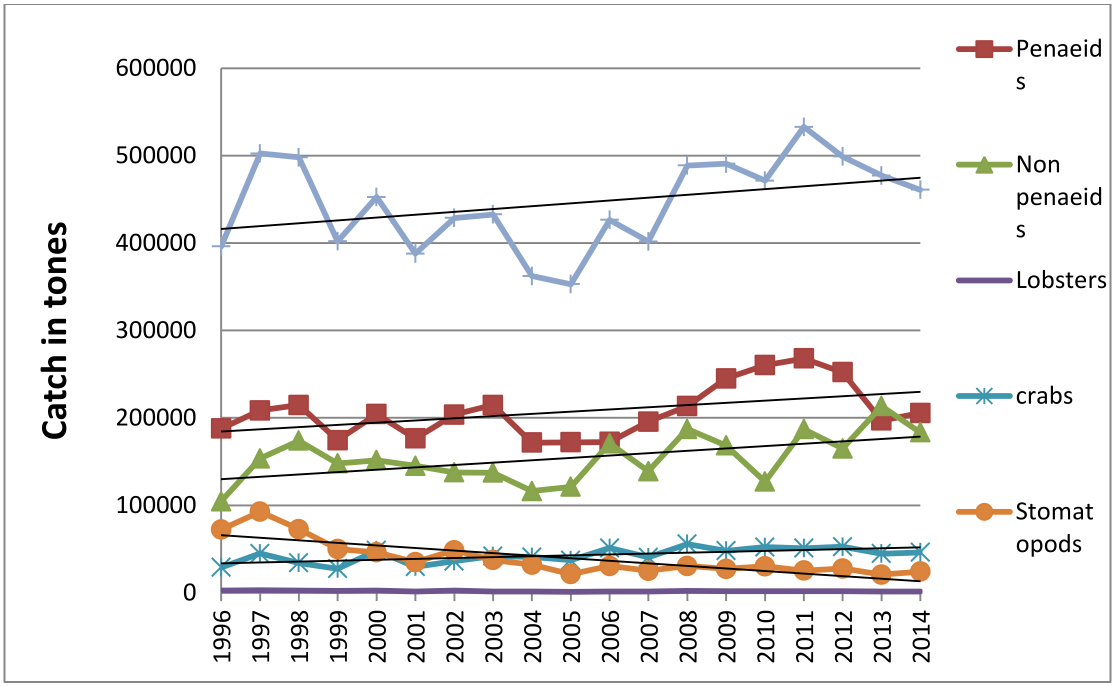

Fig.2. Group wise, trends in crustacean resource landings during 1996-2014.

Table, 2. State wise crustacean resources (t) and contribution of crustacean resources from east coast to total crustacean resources of India.

Year	west Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Total crustacean resources of east coast	Total crustacean resources of India	%
1996	7865	5494	22574	38588	556	75077	396135	19.0
1997	5163	5514	22257	40964	450	74348	502396	14.8
1998	12621	3569	26564	43435	1010	87199	498002	17.5
1999	8415	6742	35125	36133	507	86922	401895	21.6
2000	13212	12157	29340	38157	450	93316	452617	20.6
2001	22391	6809	21289	32808	485	83782	387752	21.6
2002	28719	7699	25072	40038	1000	102528	428690	23.9
2003	36104	8826	28382	34723	221	108256	432571	25.0
2004	23905	12587	26607	32395	704	96198	362214	26.6
2005	29646	17293	22158	27146	248	96491	352776	27.4
2006	28135	13094	30350	35775	1619	108973	426416	25.6
2007	28158	23077	33214	32078	500	117027	401688	29.1
2008	37703	29266	30656	35450	1441	134516	488669	27.5
2009	49191	54453	34001	37127	1861	176633	490722	36.0

2010	47952	73225	36922	35358	932	194389	471291	41.2
2011	68645	79111	33877	36840	581	219054	532851	41.1
2012	25854	68092	40726	41865	2653	179190	498977	35.9
2013	27820	17987	36973	43400	5355	131535	477062	27.6
2014	16050	20039	35421	43697	4007	119214	460902	25.9
Mean %to total crustacean resources of east coast	22.7	20.4	25.0	30.9	1.1			
Mean % to total crustacean resources of India	6.1	5.5	6.8	8.3	0.3	27.0		

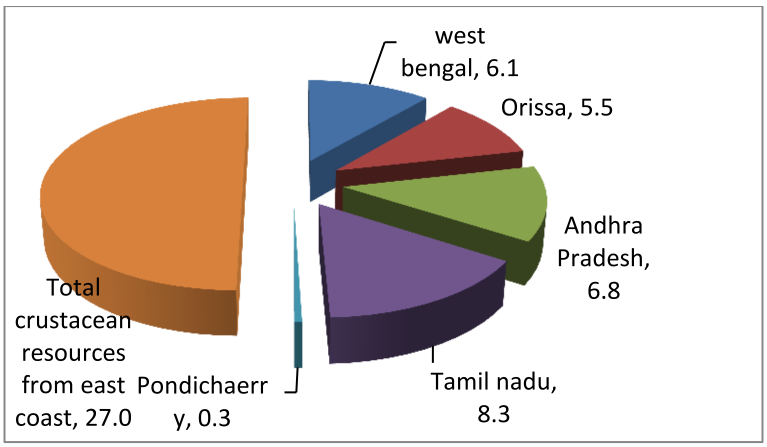

Fig. 3. Mean state wise contribution (%) of crustacean resources to total crustacean landings of India for the period 1996-2014 along the east coast.

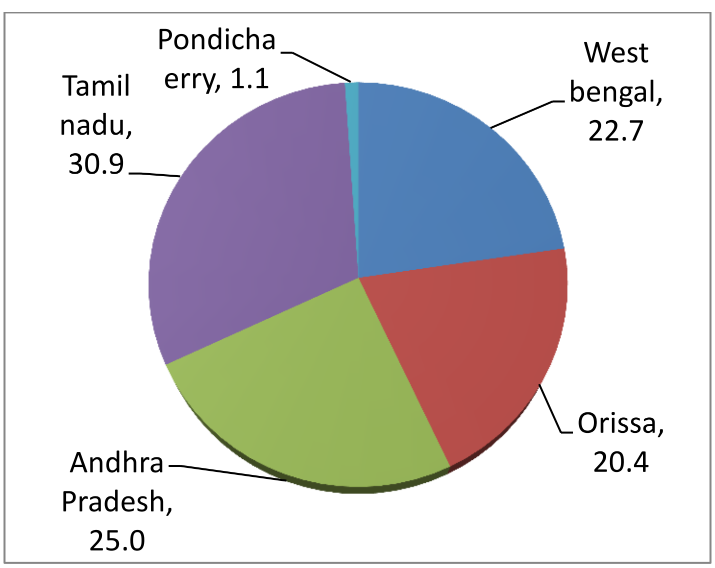

Fig.4. State wise contribution (%) to the total crustacean resources of the east coast.

Table, 3. State wise crustacean resources (t) and crustacean resources contribution from west coast to total crustacean landings of India.

Year	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Total crustacean resources of west coast	Total crustacean resources of India	%
1996	59087	22742	9840	118836	110553	321058	396135	81.0
1997	91347	32820	11925	141990	149966	428048	502396	85.2
1998	74739	19832	7617	149978	158637	410803	498002	82.5
1999	63075	23150	2573	93253	132922	314973	401895	78.4
2000	84361	21429	4705	102145	146661	359301	452617	79.4
2001	64065	23659	4998	110012	101236	303970	387752	78.4
2002	64773	43996	9222	121965	86206	326162	428690	76.1
2003	64044	26836	10478	138291	84666	324315	432571	75.0
2004	50588	23161	5919	108166	78182	266016	362214	73.4
2005	45658	35580	2684	87964	84399	256285	352776	72.6
2006	57758	28539	2904	94227	134015	317443	426416	74.4
2007	52539	33905	1405	84451	112361	284661	401688	70.9
2008	56412	25634	5687	122282	144138	354153	488669	72.5
2009	55450	27331	2761	107546	121001	314089	490722	64.0
2010	44024	32839	4383	62462	132318	276026	471291	58.6
2011	44859	27323	4094	73113	160170	309559	532851	58.1
2012	51534	29052	3995	85262	149977	319820	498977	64.1
2013	39723	23132	3363	121709	153291	341218	477062	71.5
2014	50980	29258	8376	95075	156288	339977	460902	73.8
Mean %to total crustacean resources of west coast	18.1	8.6	1.7	32.7	38.9			
Mean % to total crustacean resources of India	13.2	6.3	1.3	23.9	28.3	72.9		

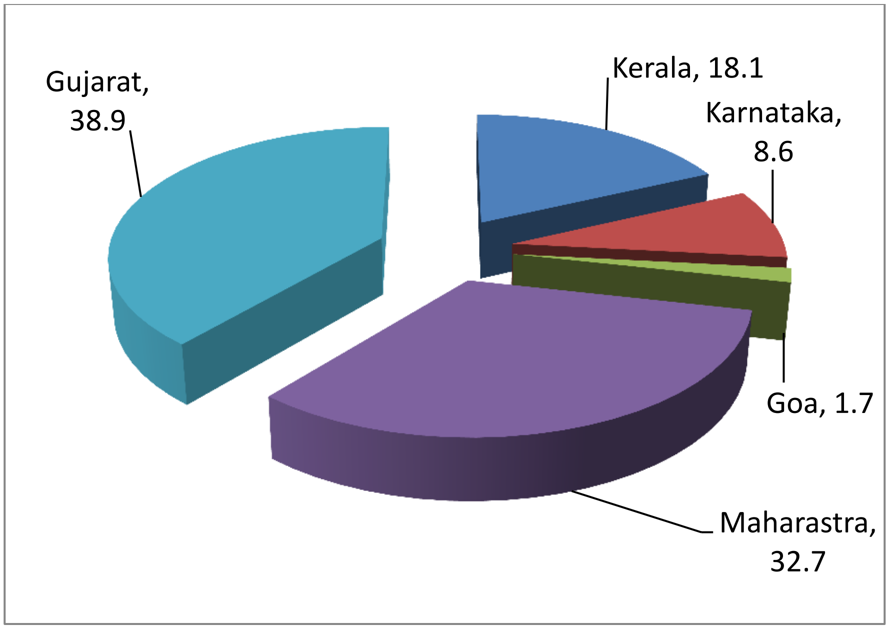

Fig.5. State wise contribution (%) to the total crustacean resources of the west coast.

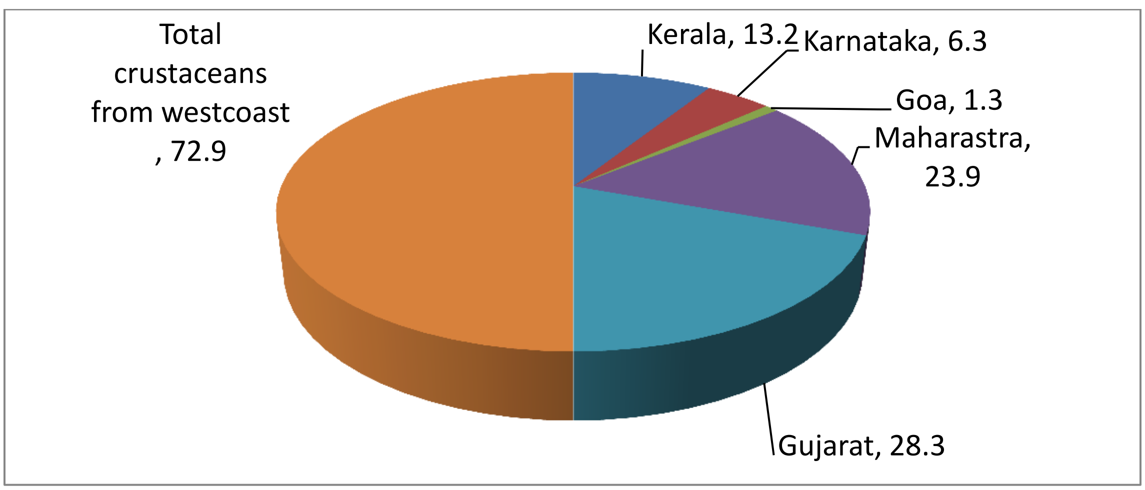

Fig.6. Mean state wise contribution (%) of crustacean resources to total crustacean landings of India for the period 1996-2014 along the west coast.

Table 4. commercially important species of penaeids, non-penaeids ,crabs, lobsters and stomatopods.

State	**Penaeids**	**Non-penaeids**	**Crabs**	**Lobsters**
Gujarat	1. *Penaeus semisulcatus* 2.*Fenneropenaeus merguiensis* 3.*Metapenaeus affinis* 4. *M. monoceros* 5. *M. kutchensis* 6. *Parapenaeopsis stylifera* 7. *P. hardwickii* 8. *P. sculptilis* 9.*Metapenaeopsis stridulans* 10. *Solenocera crassicornis*	1. *Acetes* spp 2. *N. tenuipes* 3. *E. ensirostris*	1.*Portunus sanguinolentus* 2. *C. feriatus*	1. *P. polyphagus*
Maharashtra	1. *Fenneropenaeus indicus* 2. *Metapenaeus affinis* 3. *M.monoceros* 4. *M. dobsoni* 5.*Parapenaeopsis stylifera* 7. *Solenocera crassicornis* 8. *S. choprai*	1. *Acetes* spp 2. *N. tenuipes* 3. *Exhippolysmata ensirostris*	1. *C. feriatus* 2. *P. sanguinolentus* 3. *P. pelagicus*	1. *P. polyphagus*
Karnataka	1. *Fenneropenaeus indicus* 2. *Penaeus monodon* 3. *P. canaliculatus* 1. *M. dobsoni* 2. *M. monoceros* 3. *M. affinis* 4. *P. stylifera* 5. *S. choprai*		1. *C. feriatus* 2. *P. sanguinolentus* 3. *P. pelagicus*	
Kerala	1. *M. monoceros* 2. *M. affinis* 3. *M. dobsoni* 4.*F.indicus* 5. *P. stylifera* 6. *S. choprai* 7. *Metapenaeopsis andamanensis* 8.*Aristeus alcocki*	1. *Plesionika spinipes* 2. *Heterocarpus gibbossus* 3. *H. woodmasoni*	1. *P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *C. lucifera* 5. *Podopthalmus vigil* 6. *Scylla serrata*	1. *Thenus unimaculatus* 2. *P. homarus*

Table,4 continuation				
Tamil Nadu	1.*Penaeus semisulcatus* 2.*Fenneropenaeus indicus* 3. *P. latisulcatus* 4. *Metapenaeus dobsoni* 5. *M. moyebi* 6.*Parapenaeopsis maxillipedo* 7. *P. uncta* *7. Metapenaeopsis stridulans* 8. *Solenocera hextii* 9. *Aristeus alcocki* 10. *Parapenaeus fissuroides* 11. *Parapenaeus investigatoris* 11. *Penaeopsis jerry* 12. *M. andamanensis* 13. *Solenocera alphonso*	1. *Plesionika spinipes* 2. *Heterocarpus gibbossus* 3. *H. woodmasoni*	1. *P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *C. natator* 5. *C. smithi* 6. *C. annulata* 7. *C.lucifera* 8. *C. helleri* 9. *Podopthalmus vigil* 10. *P. gladiator* 11. *P. hannii*	1. *P. homarus* 2. *P. ornatus* 3. *P. polyphagus* 4. *P. versicolor* 5. *P. ornatus* 6. *P. peniciilatus* 7.*Thenus unimaculatus*
Andhra Pradesh	1.*Metapenaeus monoceros* 2. *M. dobsoni* 3. *M. brevicornis* 4. *M. affinis* 5. *M. lysianassa* 6.*Penaeusindicus* 7. *P. monodon* *8. F. merguiensis* *9. P. japonicus* 10. *P. semisulctus* 11. *Metapeaeopsis stridulans* 12. *M. barbata* 13. *M. mogiensis* 14. *Solenocera crassicornis* 15. *S. melantho* 16. *Parapenaeopsis stylifera* 17. *P. hardwickii* 18. *P. uncta* 19. *P. maxillipedo*	1. *Acetes* spp 2. *N. tenuipe*s 3. *E. ensirostris*	1.*P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *Scylla serrata* 5. *S. olivacea*	1. *Thenus unimaculatus*

		Table ,4 continuation		
	20. *P. coromondalica* 21.*Trachypenaeus curvirostris* 22. *T.granulosus* 23. *T.sedili* 24. *Parapenaeus longipes*			
Orissa	1. *Metapenaeusdobsoni* 2. *M. monoceros* 3. *M. affinis* 4. *F. merguiensis* 5. *P. monodon* 6. *F.indicus* 7. *P. stylifera* 8. *P. hardwicki* 9. *M. lysianasa* 10.*Solenocera spp.* 11. *M. burkenroadi*		1.*P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *Scylla serrata* 5. *S. olivacea*	
West Bengal	1. *Metapenaeus dobsoni* 2. *M. monoceros* 3. *M. affinis* 4. *M. lysianasa* 5. *F. penicillatus* 6. *F. merguiensis* 7. *P. monodon* 8. *P. stylifera* 9. *P. hardwicki* *10*. *Solenocera* spp. 11. *M. burkenroadi*			

AN OVERVIEW OF SOME COMMERCIALLY IMPORTANT MARINE DEMERSAL FISHES AND FISHERY REGULATIONS

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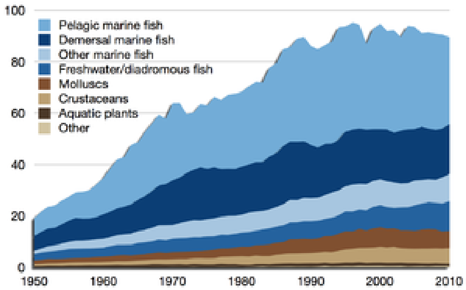


Global total capture fishery production in 2014 was 93.4 million tonnes, of which 81.5 million tonnes from marine waters and 11.9 million tonnes from inland waters. Total capture production in marine waters was 81.5 million tonnes in 2014, a slight increase on the previous two years (SOFIA, 2016).

Marine fish production of the country has shown an increase of 6.6% compared to 2015 recording a total of 3.63 million t. Of the different maritime states of India, West Bengal, Kerala, Karnataka, Maharashtra, Gujarat and the U.T. of Daman & Diu registered increase in landings whereas the other coastal states Odisha, Andhra Pradesh, Tamil Nadu, Puducherry and Goa recorded a decline in landings. Among the four regions the north-west coast comprising of Maharashtra, Gujarat and Daman & Diu contributed the maximum landings (11.83 lakh t). with 33% followed by south-west region comprising of Kerala, Karnataka and Goa together with 11.13 lakh t (31%). The states of West Bengal and Odisha which forms the northeast coast contributed 3.89 lakh t forming 11% of the all India landings.

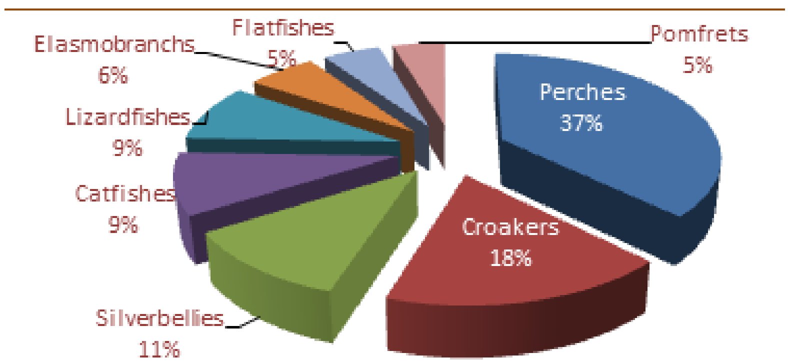


FIG. 2 CONTRIBUTION OF DEMERSALS TO ALL INDIA FISHERY 2016

During 2016, the group wise composition of demersal finfish assemblages in the Indian marine fish landings indicate that the major contributors are the perches (37%), croakers (18%), silverbellies (11%), lizardfishes (9%), catfishes (9%), elasmobranchs (6%), flatfishes (5%) and promfrets (5%).

Elasmobranchs: The elasmobranchs represented by sharks, sawfishes, guitar fishes and rays are an important group of demersal fishes which are exploited for multifarious uses of their various body parts such as the meat, fins, liver, teeth and the hide. While shark fins and shark cartilage are considered as a delicacy fetching increased export market, their liver oil is utilized in pharmaceutical industry. Shark teeth is used for ornamental purposes and their hide for a variety of leather products. Their characteristic life history pattern ie slow growth rate, delayed maturation, long reproductive cycle, low fecundity and long life span and their trans-boundary migration pattern make them susceptible to over fishing.

Shark fishing in India has progressed from being 'incidental' to 'targeted' over the years. The transformation occurred only during the 1990s due to increasing demand in the international market which has caused serious concerns about the sustainability of these catches.

Table 1. Demersal fishes landed in 2016 in India

Demersal finfish	
Elasmobranchs	
Sharks	23002
Skates	3627
Rays	26211
Eels	11171
Catfishes	80559
Lizard fishes	94817
Perches	
Rock cods	42781
Snappers	10533
Pig-face breams	12519
Threadfin breams	170349
Bull's eyes	130740
Other perches	40321
Goatfishes	30276
Threadfins	9728
Croakers	157793
Silverbellies	92764
Whitefish	6312
Pomfrets	
Black pomfret	13924
Silver pomfret	26012
Chinese pomfret	4227
Flat fishes	
Halibut	2713
Flounders	100
Soles	41015

Source: CMFRI Annual Report)

Mechanized trawl nets, gills nets and line gear operations contribute to maximum exploitation. Under the Wildlife Protection Act of India (1972), of the 88 shark species found in Indian waters, four have been listed as Protected under Schedule I of the WPA. Hunting, exploitation and trade of these species, namely, the whale shark (*Rhincodon typus*), the Pondicherry shark (*Carcharhinus hemiodon*), the Ganges shark (*Glyphis gangeticus)* and the speartooth shark (*Glyphis glyphis*), is banned. India is also a signatory party to the CITES Appendix II listing of 5 species of sharks (of which 4 species are found in Indian waters) and 2 species of manta rays, thereby initiating regulation in fin and gill plate trade in these species.

PERCHES

This group is abundant in the rocky grounds off the South west coast and south east coast of India and is exploited by, hooks and lines, traps and gill nets. All India landings of perches is 4.27 lakh tonnes. Around 42 species of groupers have been reported from different parts of India. Family Serranidae includes *Epinephelus malabaricus* (Malabar grouper), *E.tauvina* (Greasy grouper), *E.bleekeri* (Dusky-tail grouper),*E.areolatus* (Areolate grouper),*E .diacanthus* (Spring cheek grouper/ six-bandedreef cod), *E.epistictus* (Broken-line grouper), *E.fasciatus* (Red banded grouper),*E.flavocaeruleus* (Blue and yellow reef cod), *E.latifasciatus* (Banded grouper),*E.morrhua* (Banded cheek reef cod), *E.undulosus* (Brown- lined reef cod), *E.merra* (Wire netting reef cod), *E.fuscoguttatus* (Brown marbled grouper), *E.chlorostigma* (Brown spotted grouper), *Cephalopholis sonnerati* (Red coral cod) and *C.boenack* (Blue-lined seabass).

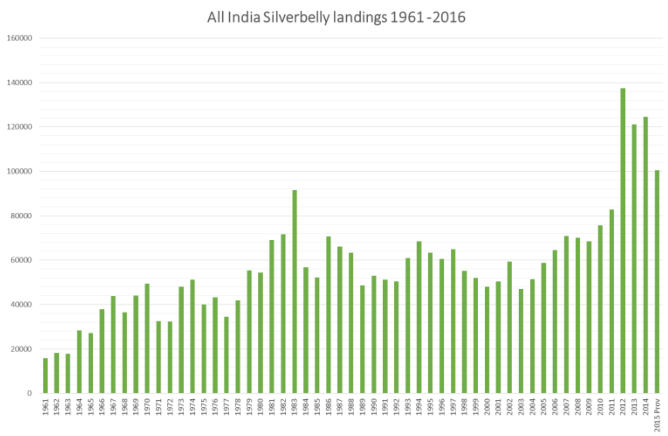
Snappers: The family Lutjanidae collectively known as snappers, contains 17 genera and 105 species, which are mainly confined to tropical and subtropical marine waters, with few occurring in estuaries. A total of 35 species under 8 genera of snappers were recorded during the present study,of which, 3 species are new additions to the Indian waters. The major species observed in the all Indialandings of snappers were *Pristipomoidestypus, L. argentimaculatus, Lutjanus gibbus,L. rivulatus, L. bohar*, and *L. lutjanus.*

Catfishes: Catfishes wide distributional range in the Indo-Pacific region. They are distributed all along the Indian coastal waters up to the middle shelf with preferential concentration on muddy grounds of 30-70 m depths. In India, catfish landings increased from 1961 -2009 but decreased in the commercial landings after 2010. The fishery is in the recovery phase now. The drastic decrease was due to exploitation of the exploitation of the mouth brooders destroying both the parents and the eggs by the fishing vessels. Catfishes migrate both vertically (diurnal migration) and horizontally (seasonal) in small schools to large shoals in response to seasonal climatic / hydrographic variations. Catfishes exhibit parental care - the male carrying the brood (25-120 eggs) in the oro-buccal cavity for 1 to 2 months' time until the juveniles (4-7 cm) are released. This group is one of the most vulnerable resources for irrational harvest during their migratory and breeding phase. With the advent of mass harvesting gear like purse seine and trawlers, there has been a continuous onslaught on this resource during the periods of south bound or north bound migrations parallel to the coast. The damage is further aggravated when their spawning shoals are exploited from the surface often causing large scale destruction of parents and egg / embryos, leading to overfishing affecting the recruitment to the population. Indiscriminate exploitation of juvenile and sub-adult populations by bottom trawlers and brooders / spawners by purse seiners has resulted in poor recruitment, spawning stock decline and infrequent shoreward migrations. Ultimately the production gradually declined in 1986-1990, though several innovative gears contributed towards the coastal fisheries in this period, with an annua l average catch of 51,244 t. The landings further declined to 40.008 t in 1991- 1995 inspite of extended fishing to deeper ground upto 80 -100 m depth and species replacements. (Menon et al. 2000)

Bulls eye: The landings of Bullseyes during2016 in India was 130740 tonnes. The major species observed in the landings are *Priacanthus hamrur*, *Cookeolus japonicas* and *Priacanthus sagittarius.*

Silverbellies: 21 species are reported in Indian waters. The fishery has improved over the period, with a major improvement in2013, but decreased after that. The major fishery area is on the Southeast coast.

Previous name	Present name
Leiognathus bindus	*Photopectoralis bindus*
L. blochi	*Nuchequula blochii*
L. edwardsi	*Equulites elongatus*
L. insidiator	*Secutor insidiator*
L. jonesi	*Eubleekeria jonesi*
L. splendens	*Eubleekeria splendens*
L. ruconius	*Secutor ruconius*
L. daura	*L. daura*
L. dussumieri	*L. dussumieri*
L. longispinis	*L. longispinis*



INSTRUMENTS/ORGANISATIONS in CONSERVATION

- Fishery Regulation Acts

-Indian Fisheries Act 1897 for regulation and protection of fisheries.

- The Indian Wildlife Act 1972. 2lb-The territorial waters, continental shelf, EEZ and other maritime zones Act 1972.
- The Marine Products Export Development Authority Act 1972
- The Kerala Marine Fishing Regulation Act and Rules 1980 (Act 10 of 1981)
- **Marine Protected Areas** (MPAs): India has 33 coastal and marine protected areas and 3 marine bio reserves, with a total area of 5,319 km^2. The protected areas cover less than 1.3% of the Indian coast
- The **International Union for Conservation of Nature (IUCN)** is the world's oldest and largest global environmental organization. Founded in 1948 a unique organization - a democratic membership union composed of over 1,200 Members, 11,000 scientific experts. Today the largest professional global conservation network and a leading authority on the environment and sustainable development in more than 160 countries. **Principle: Global production and consumption patterns are destroying our life support system – nature – at persistent and dangerously high rates.**

- **CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora)** is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

- CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union).

Additional reading:

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Marine capture fisheries-Pelagic resources and their management

Ganga.U

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Pelagic resources contribute around 50% of the total marine fish landings in India and the major contributors include the single species group comprising oil sardine (*Sardinella longiceps*), Indian mackerel (*Rastrelliger kanagurta*), Bombay duck (*Harpadon nehereus*) and the Hilsa shad (*Tenualosa ilisha*). The lesser sardines (*Sardinella* spp.), Ribbonfish (*Trichiurus lepturus, Lepturacanthus savala*), anchovies (*Stolephorus* spp. *Thryssa* spp.,), carangids (comprising scads, trevallies, pomfrets etc), seerfishes (*Scomberomorus* spp.) and tunas (coastal and oceanic) are the other major resources (Figs. 1 & 2). Different maritime states of India show different trends in landings of pelagic resources (Table 1)

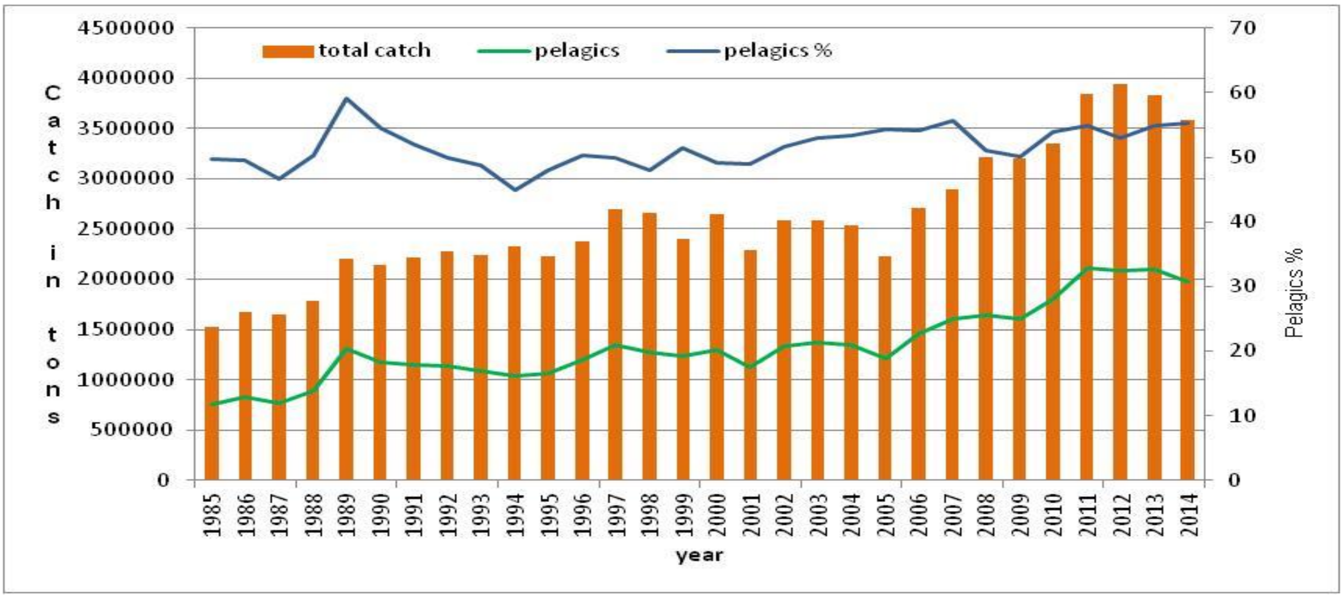


Fig. 1. Trend of annual all India marine fish landings and the contribution by pelagic fishery resources (1985 – 2014)

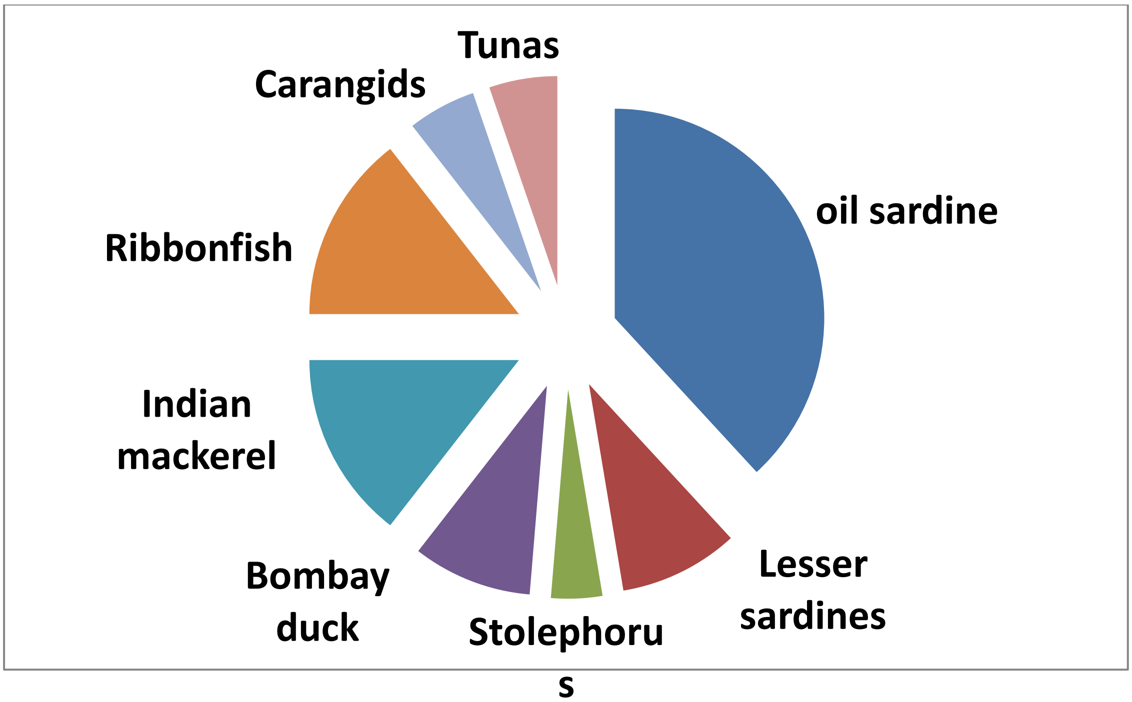


Fig.2. Resource wise contribution by major pelagic fishery resources to the total pelagic fish catch (Avg. 2005 -2014 period)

Table 1. State-wise status of marine fisheries 2016

State	**Total Marine Fish Landings 2016 (lakh t)**	**Pelagics (lakh t) & % contribution**	**Major Resources**	**Gears**
Gujarat	7.74	2.9 (39%)	Ribbonfish, clupeids, seerfish, tunnies	Dol net, trawls
Maharashtra	2.92	1.1 (41 %)	Bombay duck, Golden anchovy, Ribbonfish, Oil sardine	Seines, dol nets
Goa	0.6	0.55 (90 %)	Oil sardine, mackerel	Purse seines
Karnataka	5.3	2.8 (54 %)	Oil sardine, mackerel, ribbon fish, scads (Decapterus spp.)	Trawls and seines
Kerala	5.22	3.2 (61%)	Oil sardine, carangids, mackerel, anchovies	Ring seines

Tamil Nadu & Puducherry	6.6 0.7	3.1 (46%)	Oil sardine, Silverbellies*, mackerel, ribbonfish, tunas, seerfishes	Trawl nets, gill nets, ringseines
Andhra Pradesh	3.4	2.1 (63%)	Lesser sardines, mackerel, tunas & billfishes, ribbonfishes	Trawls, seines & gillnets
West Bengal	0.77	0.33 (43%)	Hilsa shad, clupeids, Bombay duck, Ribbonfish	Trawls, gillnets and dol nets
Odisha	1.39	0.77 (55%)	Lesser sardines, Mackerel, ribbonfish	Trawls

Indian Oil sardine *Sardinella longiceps*: It is a small lived, fast growing shoaling fish and shows high fluctuations in annual catches. Its maximum life span is less than 2 years and reaches a maximum size of 23 cm within this period. Fishes become mature at around 6 months of age when they attain sizes of about 14 cm. They are plankton feeders (phytoplankton and copepods) and their fishery is mainly confined to coastal water of less than 50 m depths. It is a highly favoured table fish in states like Kerala while it is less preferred in other coastal states of India. The oil content of the fish is very high and its highly valued for fish oil extraction and also for fish meal production. The Climate Change experienced with increasing sea surface temperature is reported to have caused fishes to migrate to cooler waters and establish themselves in deeper waters as well as the further north latitudes of the Indian coast.

Indian Mackerel *Rastrelliger kanagurta*: A short lived species, maximum 2-2.5 years life span, it reaches about 210 mm in Total Length by the age of 1 year. Its peak spawning period is during May to June on the west coast with another minor spawning peak during October - November. It feeds on copepods, phytoplankton and detritus. Catches also show strong inter-annual variations. Environmental conditions play an important role in creating favorable spawning and the first feeding for larvae required to ensure successful recruitment each year.

Bombay duck *Harpadon nehereus* : Its 'Discontinuous Distribution' pattern is characteristic and the fishery is confined to north west (Maharashtra & Gujarat) and north east coast (West Bengal, Odisha and northern Andhra Pradesh) of India. They are fished mainly by the fixed bag nets (*Dol* net) in the 15-50 m depth zone and also landed by trawlers. The fish has high water content and is easily perishable. Bulk of the catch is sundried and used for domestic consumption. Specially processed 'laminated Bombay duck' are in demand in foreign markets.

Hilsa shad *Tenualosa ilisha*: It belongs to the family clupeidae and is a shared stock among Bangladesh, India and Myanmar. An anadromous species, it forms schools in coastal waters and migrates upstream to breed. Although the resource is widely distributed all along the Indian coast, the states of West Bengal and Odisha on the north east coast of India contribute nearly 80% of the estimated hilsa landings from the marine habitat in India. Drift gill nets and seines are used in the fishery. During the monsoon season the hilsa shad is found in the estuarine/near shore areas where bulk of the catch is landed. Two well marked migrations of the marine hilsa shad into the Hoogly area during post-monsoon (September/ October) and winter (January/February) was reported by Reuben et al., (1992). The fish is a highly esteemed table fish and commands prices over 1000 Rs per kg. Hence it is also subject to high fishing pressure and there was serious decline in the catch volumes in 2015. However in 2016, the fishery had bounced back with record estimated catch of 89,109 tonnes compared to a mere 16273 t in the previous year (CMFRI, 2016).

Lesser sardines (*Sardinella* spp.): This is a highly diverse group of sardines. The resources are mainly exploited along the south east coast (Tamil Nadu and Andhra Pradesh) using gill nets, seines and pelagic /bull trawling . Commonly recorded species are the *Sardinella gibbosa*, *S. fimbriata* and *S.sirm*. They are often landed in bulk quantities and sundried/ taken to fish meal plants depending on market conditions.

Anchovies: Five genera *Encrasicholina, Stolephorus, Thryssa, Setipinna* and *Coilia* are recognized and constitute seasonal fisheries mostly being fished in Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Maharashtra. The whitebaits are constituted by the *Encrasicholina and Stolephorus* genera only. They are highly favored as food fish in most of these states and some are used for dry fish trade and occasionally for fish meal. Along the southwest coast the whitebaits exhibit seasonal migration by the shoals moving southward in April- May and concentrating in the Gulf of Mannar and Palk Bay during the southwest monsoon. After this, the shoals again disperse and spread and occur from Quilon (Kerala) in the south to Ratnagiri (Maharashtra) in the north. All the fishes are short lived (< 2 years) with fast growth and hence considered as 'annual crops' that should be harvested optimally.

Ribbonfishes: This is a resource which has high demand in the export market. Among the various species available in Indian waters, *Trichiurus lepturus* is the most important component in terms of volume and value followed by *Lepturacanthus savala*. The resource is mainly exploited by trawls. These fishes grow upto 1m and are strongly carnivorous in their feeding habits with anchovies being a preferred food item.

Carangids: This is a highly diverse group comprising of several species. Groups like the scads are smaller and abundant in coastal waters which are caught using seines and trawls. Several other species grow to large sizes and occur in hooks and line/ drift gill net fisheries. Abdussamad et al., (2007) based on body shape, scale and lateral line scute counts, gill rakers, head shape, fin characters, body colour and mouth characterstics identified 49 species of carangids belonging to 20 genera (Table 2).

Table 2. Various carangid groups and genera recorded in Indian seas

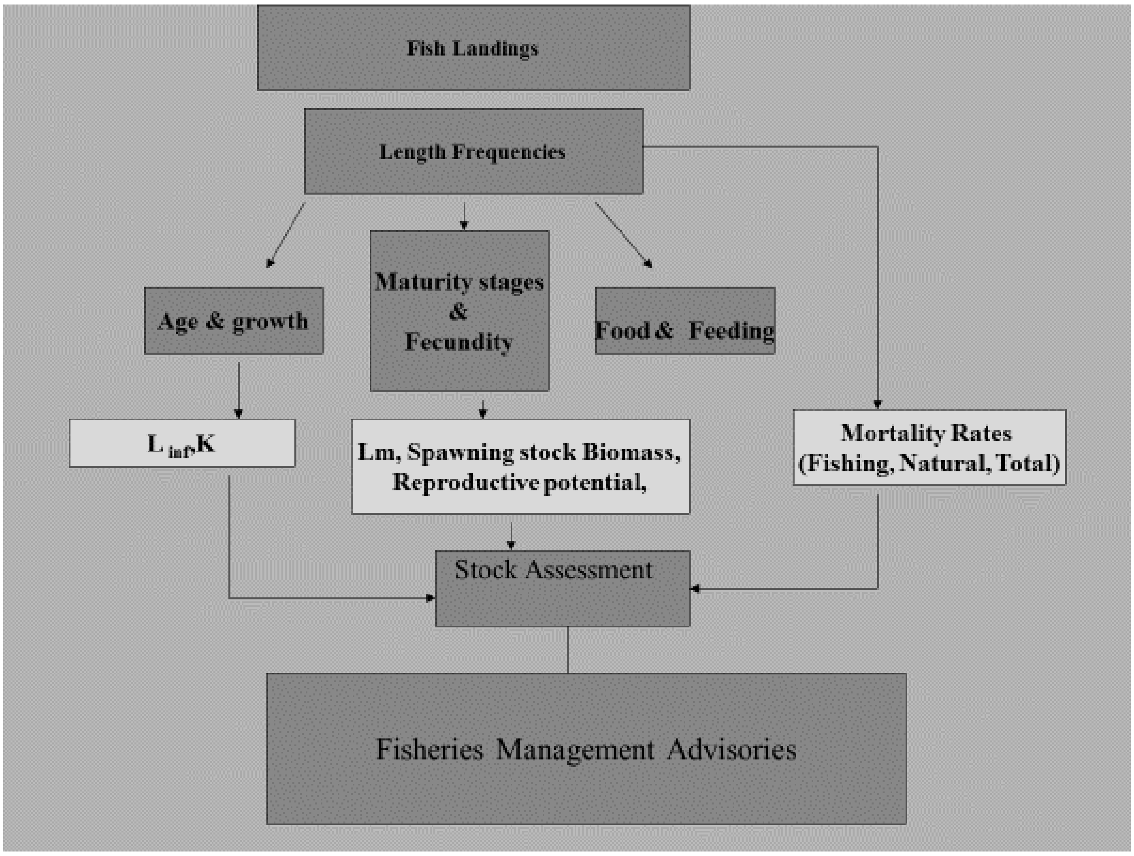
Group	**Genera**
Scads	*Alepes, Atule, Selar, Selaroides, Decapterus, Megalaspis*
Runners	*Elegatis*
Trevallies	*Atropus, Carangoides, Caranx, Ulua, Seriolina, Seriola,*
Pilotfishes	*Gnathanodon*
Jacks	*Naucrates, Uraspis*
Black Pomfret	*Parastromateus*
Queen fishes	*Scomberoides*
Pompanos	*Alectis, Trachinotus*

Seerfishes: These are high unit value fishes (*Scomberomorus commerson, S.lineolatus, S.guttatus* and wahoo *Acanthocybium solandri*). They are mostly exploited by drift gill nets operating in deeper waters (>80 m depths). Juveniles (<70 cm) occur as by-catch in trawls. They can grow upto 1.5 m and have a longer life span of 8-10 years and hence exhibit slower growth. Hence fishing regulations are required so that every year there are adequate numbers of juvenile fishes surviving to grow to bigger size, reproduce and produce new recruits to the fishery.

Bill fishes: These fishes are oceanic, highly migratory and often are straddling stocks. They have high demand in international markets and are exploited intensively in the Indian Ocean region using hooks and line, drift gill nets and troll lines. Marlins (*Makaira* spp.,) , sword fish (*Xiphias gladius*) and sailfish (*Istiophorus platypterus*) are mainly exploited.

Tunas : This group comprises coastal (*Euthynnus affinis, Auxis thazard, Auxis rochei*), neretic (*Thunnus tonggol, Sarda orientalis*) and oceanic (Skipjack *Katsuwonus pelamis* , yellowfin *Thunnus albacares*, Big eye *Thunnus obesus* and dogtooth tuna *Gymnosarda orientalis*). Skipjack is favored for *Masmin* production (a smoke dried tuna product from Lakshadweep) while the highly fresh yellowfin tuna is preferred for processing into premium export quality *Sashimi* tuna. Hooks and lines, troll lines, purse seines and drift gill nets land the tuna catches on the Indian mainland. Lakshadweep has a specialised pole and line fishery for skipjack tuna. Coastal tunas contain higher amount of red meat and are mainly preferredd for domestic consumption or producing canned tuna .

Resources are routinely monitored based on a sampling scheme from the commercial fishing vessels and length frequencies of the various commercially important species and their biology are recorded for making an assessment of the fisheries and the stock status (Fig.3).



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GIS applications in aquatic environment

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What is GIS?

Geographic information system (GIS) is a tool for making and using spatial information and it is mainly concerned with location of the features as well as properties/attributes of those features. It helps us gather, analyse and visualize spatial data for different purposes. A GIS quantifies the locations of features by recording their coordinates which are the numbers that describe the position of these features on Earth. The uniqueness of GIS is its ability to do spatial analysis. GIS helps us analyse the spatial relationships and interactions. Sometimes, GIS proves to be the only way to solve spatially-related problems and it is one of the most important tools that aid in decision making process. GIS basically helps to answer three questions; How much of what is where? What is the shape and extent of it? Has it changed over time?

Globally, on an average, GIS tools save billions of dollars annually in the delivery of goods and services through proper route planning. GIS regularly help in the day-to-day management of many natural and man-made resources, including sewer, water, power, and transportation networks. Applications of GIS in marine and coastal ecosystem study is an emerging field today. GIS help us identify and address environmental problems by providing crucial information on where problems occur and who are affected by them. It also helps us identify the source, location and extent of adverse environmental impacts. GIS enable us to devise practical plans for monitoring, managing, and mitigating environmental damage. Human impacts on the environment, conflicts in resource use, concerns about pollution, and precautions to protect public health have spurred a strong societal push for the adoption of GIS.

GIS is composed of hardware, software, data, humans and a set of organizational protocols. The selection and purchase of hardware and software is often the easiest and quickest step in the development of a GIS. Data collection and organization, personnel development and the establishment of protocols for GIS use are often more difficult and time consuming endeavours. A fast computer, large data storage capacities and a high quality, large display form the hardware foundation of most GIS. GIS software provides the tools to manage, analyse, and effectively display and disseminate spatial information. GIS as a technology is based on geographic information science and is supported by the disciplines like geography, surveying, engineering, space science, computer science, cartography, statistics etc.

In GIS, we handle the spatial and attribute data sets. Spatial data describes the absolute and relative location of geographic features while the attribute data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature. Attribute data is also referred to as tabular data. Vector and raster are two different ways of representing spatial data. Raster data is made up of pixels (or cells), and each pixel has an associated value. A digital photograph is a simple example of a raster dataset where each pixel value corresponds to a particular colour. In GIS, the pixel values may represent elevation above/below sea level, or chemical concentrations, or rainfall etc. The key point is that all of this data is represented as a grid of (usually square) cells. Vector data consists of points, lines, and polygons. The individual points are stored as pairs of (x, y) co-ordinates. The points may be joined in a particular order to create lines, or joined into closed rings to create polygons, but all vector data fundamentally consists of lists of co-ordinates that define vertices, together with rules to determine whether and how those vertices are joined.

As with many other systems, GIS basically works on the principle of '*GIGO*' that is *garbage in garbage out*. Hence the quality of data that you feed into GIS is very important and it determines the quality of the end products. But, when used wisely, GIS can help us live healthier, wealthier, and safer lives.

Examples of GIS applications in aquatic environment

GIS can play an important role in the monitoring and management of aquatic environment. GIS is ideally suited as a tool for the collection, collation, analysis and visualization of data derived from diverse sources including those from distributed measurement stations (e.g. field-based water quality sensors). The ability of GIS to aggregate data from various inputs and present them in map form is unique and helps in strengthening the awareness about the conditions of our environment. GIS is also a valuable tool in the decision-making process.

Monitoring of environmental parameters

The environmental parameters like temperature, salinity, dissolved oxygen, nitrate etc. are very important and affect the species distribution and abundance of that aquatic system. GIS helps to analyse and make the depth and time profiles of different aquatic environmental variables which in turn aid us in better understanding the nature and properties of the system under study. For example, contour plots of temperature and salinity profiles of the coastal waters help us to understand the process of coastal upwelling in a better way.

Applications in habitat mapping and change detection

Remote sensing, due to its advantages like synoptic view, multispectral data, multi-temporal coverage and cost effectiveness, plays a major role in habitat mapping and change detection. It has proved to be a practical approach to study complex geographic terrain types and to collect data from diverse, inaccessible ecosystems. Integrated GIS and remote sensing have already been successfully applied to map and monitor marine and coastal ecosystems. Satellite imagery is available for most of the world since 1972, with the launch of LANDSAT by USA. This treasure trove of information help us to map and monitor the changes that happened to our coastal areas like land reclamation, destruction of mangroves, shrinkage of estuaries, lakes and other water bodies that are directly linked to fisheries. The multi-date nature of satellite imagery permits monitoring dynamic features of landscape and thus provides a means to detect major land cover changes and quantify the rates of change. GIS and remote sensing are widely used to monitor and map the habitats namely seagrass/seaweed/coral reef.

Aquaculture site selection

A suitable site is a pre-requisite for any successful aquaculture activity. Optimal aquaculture sites aids in better management of the resources and ensuring sustainability of the farming activity. There are lot of reported works on the identification suitable sites for aquaculture using GIS. There are many criteria, guideline and essential factor for selection of site for aquaculture. The parameters such as reported water flow, volume availability, water quality, weather parameters, access and location of utilities, topography of site, slope of land, legislation concerning water rights etc. goes into the decision making process. GIS offers the best platform to combine all these information and identify the areas that qualify optimal set of parameters which would be the best suited areas for aquaculture. Weighted overlay is one of the most used operations in GIS in such analyses.

There are many more applications of GIS in the field of aquatic environment and the reader is advised to go through the references sited below to get an idea about the use of GIS in general and in the study of aquatic environment.

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IDENTIFICATION OF GROUPERS AVAILABLE IN INDIAN WATERS

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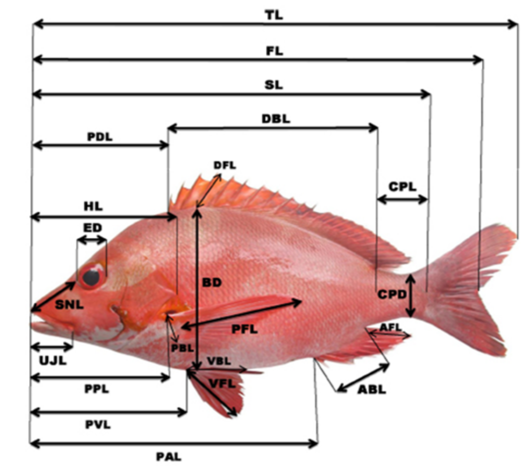
Family Serranidae - Sea basses



TL – Total Length	BD – Body Depth	ABL – Anal Base Length
SL – Standard Length	DFL – Dorsal Fin Length	CPD – Caudal Peduncle Depth
FL – Fork Length	DBL – Dorsal Base Length	CPL – Caudal Peduncle Length
HL – Head Length	PFL – Pectoral Fin Length	PDL – Pre-dorsal Length
ED – Eye Diameter	PBL – Pectoral Base Length	PPL – Pre-pectoral Length
SNL – Snout Length	VFL – Ventral Fin Length	PVL – Pre-ventral Length
UJL – Upper Jaw Length	VBL – Ventral Base Length	PAL – Pre-anal Length
	AFL – Anal Fin Length	

Sea basses are mostly marine in habitat with widespread occurrence from tropical and temperate seas. Fishes are characterised by an opercle with three spines with the main spine in centre and one each above and below. Body scales are generally ctenoid with cycloid scales also reported. Lateral line is continuous, not extending onto caudal fin. Single continuous dorsal fin, in some with notches, 7- 13 spines. Anal fin with 3 spines; caudal fin usually rounded, truncate, or lunate. Tip of maxilla exposed, pelvic fin with one spine and five soft rays; seven branchiostegal rays usually present. Colour patterns are helpful for identification of species, but variations are common based on ground of capture. Colour changes have also been noticed when the fish are brought to the shore. Red List assessments show that 20 species (12%) risk extinction if current trends continue, and an additional 22 species (13%) are considered to be Near Threatened.

Three subfamilies Serraninae, Anthinae and Epinephelinae are recognized worldwide with about 64 genera and 529 species (Fraser and Pauly online).

SubfamilySerraninae

Synchronous hermaphroditism, with both sexes functional at the same time in a single individual, is characteristic of most species in the Subfamily Serraninae. Although these synchronous hermaphrodites can fertilize their own eggs, they normally spawn in pairs and alternate the release of eggs or sperm in order to have their eggs fertilized by the other fish.

The subfamily includes 13 genera *Acanthistius, Bullisichthys, Centropristis, Chelidoperca, Cratinus, Diplectrum, Dules, Hypoplectrus, Paralabrax, Parasphyraenops, Schultzea, Serraniculus* and *Serranus* with 86 valid species.

Subfamily Anthinae

Includes around 21 genera, *Acanthistius, Anthias, Caesioperca, Caprodon, Epinephelides, Giganthias, Hemanthias, Holanthias, Hypoplectrodes, Lepidoperca, Luzonichthys, Plectranthias, Pronotogrammus, Pseudanthias, Rabaulichthys, Sacura, Serranocirrhitus, Stigmatonotus, Tosana, Tosanoides, and Trachypoma,* with about 214 species and is mostly being Indo-West Pacific in distribution.

Subfamily Epinephelinae

The tribe Epinephelini is one of the most speciose percoid assemblages, with hypothesized monophyly comprising 167 species.

The subfamily includes around 30 genera *Aethaloperca, Alphestes, Anyperodon, Cephalopholis, Cromileptes, Dermatolepis, Epinephelus, Gonioplectrus, Gracilia, Mycteroperca, Paranthias, Plectropomus, Saloptia, Triso, Variola, Aulacocephalus, Belonoperca, Diploprion, Bathyanthias, Liopropoma, Rainfordia, Aporops, Grammistops, Jeboehlkia, Pogonoperca, Pseudogramma, Rypticus, Suttonia* and *Niphon.*

Key to the genera of Serranidae

Less than 1/2 of upper border of opercle joined to body by skin; dorsal-fin spines VII to XI .... (tribe Epinephelini)- **1a**

1a. Dorsal-fin spines VII or VIII; lower edge of preopercle with 1 to 3 enlarged spines (usually hidden by skin, but these spines can be detected by running a finger or probe along preopercle edge).

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Anal-fin spines weak, the first and second covered by skin; preorbital depth 0.7 to 2 times eye diameter; head length 2.8 to 3.1 times in standard length . . . . ***Plectropomus***

1b. Dorsal-fin spines IX to XI; lower edge of preopercle smooth except for a few species of *Epinephelus* with 1 to 4 enlarged serrae **2**

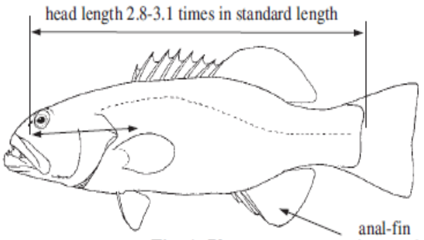
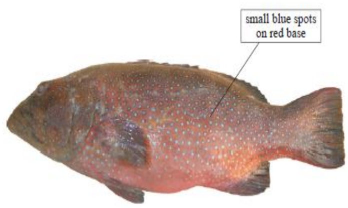
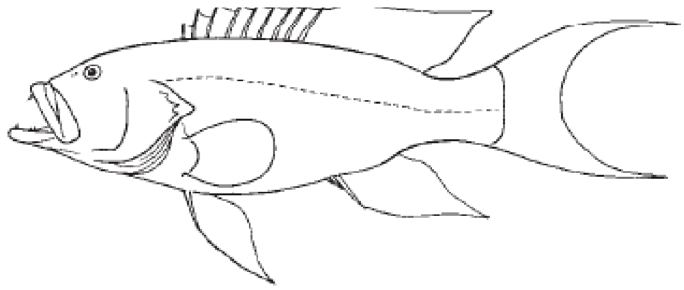


Fig. 4 ***Plectropomus***

Plectropomus areolatus

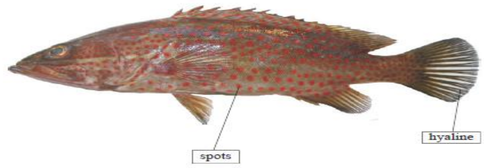


2a. Caudal fin deeply lunate or forked; dorsal-fin spines IX. . . . . . ***Variola***



2b. Caudal fin rounded, truncate, or concave; dorsal-fin spines 9-11............**3**

3a. No teeth on palatines; body and head elongate and markedly compressed, the greatest body width 11 to 15% of standard length and more than 3 times in head length ...... ***Anyperodon leucogrammicus***



3b. Palatines with teeth; body compressed in some species, but its width only 1.8 to 3 times in head length **4**

4a. Dorsal profile of head markedly concave; dorsal-fin spines X; rear nostrils of adults a long vertical slit . . . . *Cromileptes altivelis*

4b. Dorsal profile of head straight, convex or slightly concave; dorsal-fin spines IX or XI. **5**

5a. Pectoral fins distinctly asymmetric, the fifth or sixth rays longest; dorsal fin with IX spines and 17 or 18 soft rays; caudal fin truncate . . . . ***Aethaloperca rogaa***

5b. Pectoral fins symmetric or nearly so, the middle rays longest; dorsal fin with IX to XI spines and 12 to 21 soft rays; caudal fin rounded, truncate, or emarginate . . ***18***

6a**.** Dorsal-fin spines 9 . . . .***19***

6b**.** Dorsal-fin spines 11 . . . .***20***

19a**.** Caudal fin rounded; dorsal-fin membranes distinctly incised between spines. . . . . ***Cephalopholis***

19b. Body depth 2.4 to 4.1 times in standard length, usually less than head length; dorsal fin with XI spines and 12 to 19 soft rays, the base of soft-rayed part shorter than or equal to that of spinous part. . . . . .***Epinephelus***

Key to the species of *Cephalopholis* occurring in the area

1. Caudal fin rounded; head length 2.2 to 2.7 times in standard length; colour pattern not of alternating stripes of blue and orange-yellow ***2***

2a. Anal-fin rays usually 8; colour generally brown to dark brown **3**

2b. Anal-fin rays 9 (rarely 10); colour generally red, orange, or yellow **8**

3a. Small dark spots or dark-edged pale blue spots on head and/or body **4**

3b. No small dark spots or blue ocelli on head or body **5**

4a. Dorsal-fin rays 15 to 17; lateral scale series 92 to 106; pectoral-fin length 1.5 to 1.8 times in head length; blue ocelli on head, body, and basally on median fins; juveniles greenish grey, the median fins yellow . . . .***Cephalopholis cyanostigma***

4b. Pectoral fins short, their length 1.5 to 1.8 times in head length; colour generally brown or yellowish brown, with dark blue lines on head, body, and fins; black spot between upper. 2 opercular spines . . . .***Cephalopholis formosa***

5a. Body brown, with 7 to 8 more or less distinct dark bars; fins dark brown, with pale blue line caudal fin corner. . . . . . .***Cephalopholis boenak***

5b. Dorsal-fin rays 15 to 17; lower limb of first gill arch with 17 to 19 gill rakers; colour dark brown, covered with small dark-edged blue ocelli; 6 pale bars often visible on rear half of body . . . .***Cephalopholis argus***

6. Dorsal-fin rays usually 14 or 15; lower limb of first gill arch with 13 to 16 gill rakers; no auxiliary scales on body scales; colour not as above **7**

7a. Lateral-line scales 66 to 80 colour generally red to reddish brown with widely scattered whitish blotches (Indian Ocean) or generally brownish, covered with small dark red to reddish brown spots and irregular white blotches. . . . . . . ***Cephalopholis sonnerati***

7b. Lateral-line scales 45 to 68; colour not as above **8**

8a. Lateral-line scales 54 to 68; caudal fin blackish red, with red pectoral fins. . . . . . . ***Cephalopholis urodeta***

8b. Lateral-line scales 45 to 56; colour not as above **9**

9a. Lateral scale series 79 to 90; head length 2.2 to 2.4 times in standard length; dark brown saddle spot on caudal peduncle, followed by a smaller spot; submarginal dark streak at corners of caudal fin . . . .***Cephalopholis leopardus***

11b. Lateral scale series 90 to 121; head length 2.3 to 2.6 times in standard length; colour not as above **12**

12a. Head, body, and fins covered with small blue ocelli **13**

12b. No blue spots on head, body, or fins **14**

`

13a. Body with 4 or 5 dark blotches along base of dorsal fin, a faint blotch on nape and 2 smaller ones on peduncle (blotches sometimes merging with or being replaced by dark red vertical bars); most specimens with dark-edged blue lines radiating from eyes . . . .***Cephalopholis sexmaculata***

13b. No dark blotches on body or blue lines radiating from eyes . . . .***Cephalopholis miniata***

14a. Edge of subopercle and interopercle distinctly serrate; pelvic fins usually reaching anus, their length 1.6 to 2 times in head length; colour generally orange-yellow to orange-red or golden, with red to orange dots on head and dorsally on body . . . .***Cephalopholis aurantia***

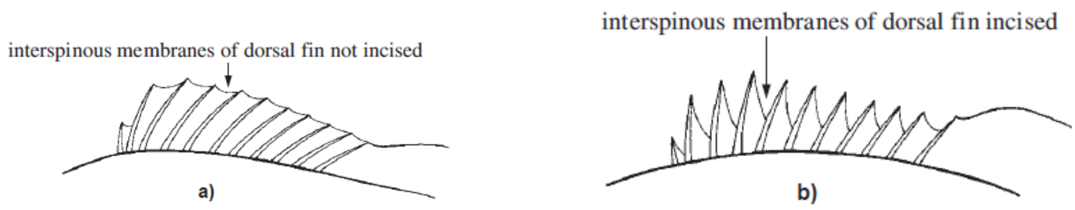
Key to the species of *Epinephelus* occurring in Indian waters

1a**.** Caudal fin of adults emarginate to truncate (slightly rounded on some *E. bleekeri* and juveniles, and convex if broadly spread in adults) ***2***

1b**.** Caudal fin rounded (truncate on some *E. fasciatus* from Oceania) ***12***

2a**.** Interspinous membranes of dorsal fin not incised. ***3***

2b**.** Interspinous membranes of dorsal fin incised. ***6***



3a**.** Gill rakers elongate, no rudiments, 20 to 23 rakers on lower limb of first gill arch; dorsal-fin rays 17 to 19; colour purplish to brownish grey with yellowish brown dots on head and longitudinal brown lines on dorsal part of body (lines usually lost on large adults) . . . .***Epinephelus undulosus***

3b**.** Gill rakers not elongate and rudiments often present, 13 to 18 rakers on lower limb of first gill arch; dorsal-fin rays 15 to 17; colour not as above ***4***

4a**.** Second dorsal-fin spine of adults elongated, its length 1.8 to 2.4 times in head length; total gill rakers on first gill arch 20 to 23; body depth 2.7 to 3.2 times in standard length; body reddish brown with a white dot on each scale; broad dark red margin on spinous portion of dorsal fin . . . . ***Epinephelus irroratus***

4b**.** Second dorsal-fin spine not elongate (third or fourth spines longest); total gill rakers on first gill arch 24 to 28; body depth 2.3 to 2.9 times in standard length ***5***

5a**.** Body dark purplish grey with scattered irregular whitish blotches; body depth 2.6 to 2.9 times in standard length . . . .***Epinephelus multinotatus***

5b**.** Head, body, and fins bluish grey with numerous blackish dots; large adults with scattered irregular blackish spots and blotches, most smaller than pupil; body depth 2.4 to 2.7 times in standard length . . . .***Epinephelus cyanopodus***

6a**.** Lateral-line scales 48 to 54; head and at least front of body with small spots, either yellow (pale in preservative) or brown ***7***

6b**.** Lateral-line scales 56 to 76; spots on head and body dark brown or absent ***10***

7a**.** Caudal fin truncate to slightly rounded; body depth 3.0 to 3.5 times in standard length; head, body, dorsal fin, and upper third of caudal fin with small orange-yellow spots, the lower two-thirds of caudal fin dark grey; anal and paired fins dusky, without spots . . . .***Epinephelus bleekeri***

7b**.** Caudal fin slightly emarginate (truncate on some *E. chlorostigma*); body depth 2.7 to 3.4 times in standard length; spots on head, body, and fins yellow or yellowish brown to dark brown; anal fin with spots. ***8***

8b**.** Head, body, and fins covered with small, close-set, yellowish brown to dark brown spots (dark in preservative) ***9***

9a**.** Dorsal-fin rays 15 to 17; anal fin of adults rounded to slightly angular, the longest soft ray 2.0 to 2.6 times in head length; 14 to 16 gill rakers on lower limb of first gill arch; pyloric caeca 11 to 17; dark spots on body of adults about equal to pupil . . . . . .***Epinephelus areolatus***

9b**.** Dorsal-fin rays 16 to 18; anal fin of adults angular or pointed, the longest soft ray 1.9 to 2.3 times in head length; 15 to 18 gill rakers on lower limb of first gill arch; pyloric caeca 26 to 52; dark spots on body of adults distinctly smaller than pupil . . . .***Epinephelus chlorostigma***

12a**.** Anal-fin rays 9 (rarely 10); body with 5 dark bars below dorsal fin, the last 2 bars as broad as preceding bars; 2 pale interspaces below soft dorsal fin . . . . ***Epinephelus octofasciatus***

12b. Anal-fin rays 8 (rarely 7 or 9); colour not as above ***13***

13. Lateral-line scales 56 to 65; lateral body scales smooth; rear nostrils and anterior nostrils subequal; juveniles with 2 broad, longitudinal, black-edged whitish bands that disappear in adults, the dark edges breaking into dashes and spots, which may be lost in large adults . . . . . . ***Epinephelus latifasciatus***

14. Lateral-line scales with branched tubules; eye small, its diameter about 1/8 head length for specimens of 20 cm length, about 1/9 head length at 35 cm, and 1/13 head length at 145 cm standard length; interorbital wide, the width more than 1/5 head length for specimens of 23 to 153 cm standard length; maximum length about 270 cm; juveniles yellow, with 3 broad black bars on body and irregular black bands on head . . . . . . ***Epinephelus lanceolatus***

Some common species

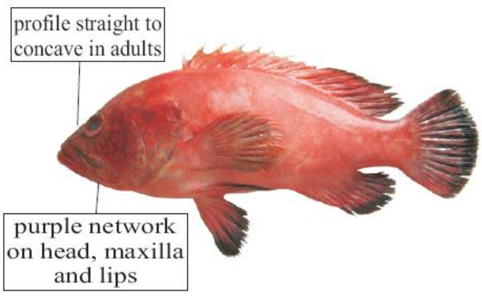
Aethaloperca rogaa **(Forsskal, 1775)**

Redmouth grouper

D IX, 17; A III, 8; P 17-18; V I, 5.
Body rounded its depth greater than head length; mouth slightly superior; dorsal profile of head steeply sloped; small hump on nape; pre-operculum finely serrated; operculum with 3 undeveloped spines; pelvic fins equal to pectorals, reaching the level of anus or beyond; caudal fin truncate.
Body uniformly dark brown to black; reddish inside the mouth, gill cavity and upper jaw membrane; soft-rayed part of dorsal fin and caudal fin margin white white.

Cephalopholis sonnerati **(Valenciennes, 1828)**

Tomato hind

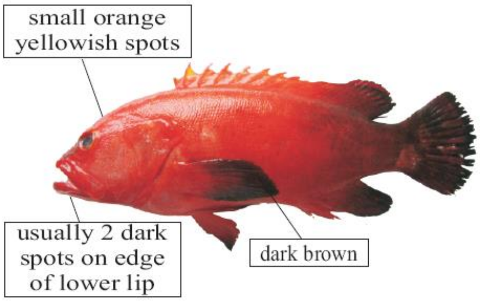


D IX, 15; A III, 9; P 17-18; V I, 5; Gr 14 to 16.

Body depth, greater than or equal to head length; dorsal profile of head near eye and nape strongly convex; mouth small, slightly superior; maxilla reaches posterior of eye; pre-operculum rounded; **operculum spines very small, poorly developed**; Body bright orange to red, with scattered bluish-white spots; head purplish to red with numerous close-set orange-red spots; opercular flaps dark reddish; all fins reddish, the membranes of soft dorsal, caudal, anal, pectoral and pelvic fins dark red to dusky.

Cephalopholis urodeta

Similar to *C. sonnerati*, but differs in the absence of the reticulate pattern in *C. sonnerati*



***Epinephelus polyphekadion* (Bleeker 1849)**

Camouflage grouper

D XI, 15; A III, 8; P 16; V I, 5; LL 47 to 52; Gr (8-10) + (15-17).

Dorsal profile of head evenly convex; maxilla reaches rear edge of eye; pre operculum rounded, the serrae at corner slightly enlarged; two undeveloped spines in operculum; inter spinous membranes moderately incised; caudal fin rounded; body scales ctenoid.

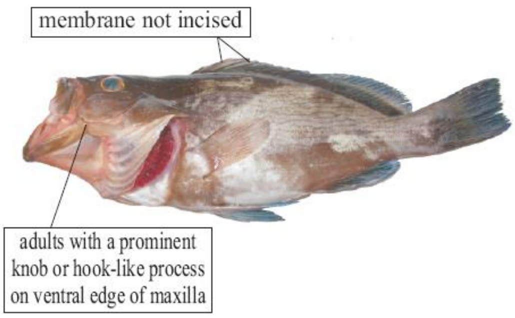
Body pale brownish covered with numerous small dark brown spots; some irregular dark blotches superimposed with the spots scattered in head and body; **a prominent black blotch on caudal peduncle**; dark spots extend all over head, including lower jaw, lips and inside of mouth; numerous small white spots on fins and a few on head and body.

***Epinephelus undulosus* (Quoy & Gaimard 1824)**

Wavy-lined grouper

D XI, 20; A III, 8; P 18; V I, 5; LL 70 to 75.

Eyes small; mouth superior to slightly protractile; pre-operculum highly serrated at the angle; operculum notched with 2 undeveloped spines; **dorsal fin membrane not notched** between the spines; body scales ctenoid, except on belly; caudal fin truncate to slightly concave. Body generally brownish to purplish grey, usually with golden brown to yellowish spots on head and upper body, which becomes wavy longitudinal lines in mid body; median fins and pelvic fin black to brown in base and bluish in the tip; preserved specimen becomes brownish with dark spots and lines.

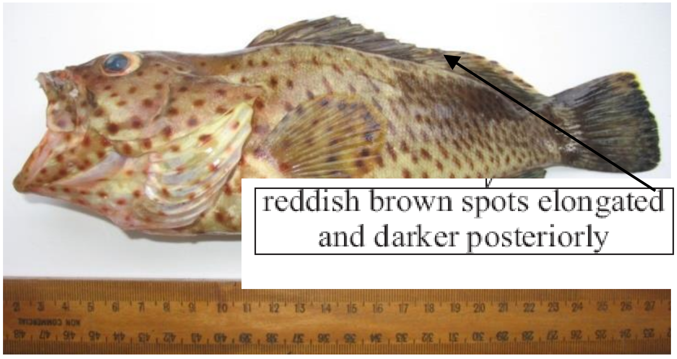


***Epinephelus longispinis* (Kner 1864)**

Longspine grouper

D XI, 16; A III, 8; P 18; V I, 5; LL 49 to 53; Gr (8 to 11) + (15 to 17).

Body deep, upper edge of operculum straight or slightly convex, with 3 undeveloped spines; the third or fourth spine longest, its length contained 2.1 to 2.6 times in head length; caudal fin rounded, convex.



Body pale to brownish and grey laterally; reddish to dark brown spots all over the body, which is round in head and slightly elongated in sides; some dark spots or blotches at dorsal fin base; median and paired fins with dark brown spots; tip of the fins slightly yellowish; preserved specimen becomes brownish with dark spots.

***Plectropomus leopardus* (Lacepede 1802)**

Leopard coral grouper

D VII, 12; A III, 8; P 16; V I, 5; LL 89 to 99; Gr (1-3) + (6-10).

Body elongate, robust; Head comparatively small, 2.7 to 3.1 times in standard length; dorsal profile of the head slightly slopped, with a concave insertion near nape; eyes slightly prominent; mouth oblique, slightly superior; preoperculum rounded, with 3 large, spines along lower half; operculum with 3 flat spines, the upper and lower spines covered by skin; pectoral fins subequal to pelvic fins; caudal peduncle broad; caudal fin emarginated.

Body brownish to orange-red, with numerous small dark-edged, blue spots on head and body (except ventrally) and fins; spots slightly elongated near mid body; pectoral fins reddish with darker rays; a indistinct dark band at rear margin of caudal fin.

Variola albimarginata **(Baissac 1953)**

White-edged lyretail

D IX, 14; A III, 8; P 18; V I, 5; LL 120-130; Gr (7-9) + (13-16).

Body elongated, moderately deep; dorsal profile of head gently sloped; eyes small; mouth oblique, terminal; jaws with sharp canine teeth; maxilla reaches beyond the eye; pre-operculum finely serrate; operculum spines not well developed; soft rays tips of fins slightly elongated; caudal fin crescentic, the upper and lower rays elongate.

Brownish orange to reddish with numerous irregular, small whitish to pink or lavender spots to streaks; fins colour same as body except pectoral fin and caudal fin rear margin; rear margin of caudal fin dusky with a narrow white edge; pectorals yellowish; preserved specimens changes complete brownish white.

Epinephelus coeruleopunctatus **(Bloch, 1790)**

White Spotted grouper

D XI, 15; A III, 8; P 18; V I, 5; LL 52-62; Gr 10+14-17.

Body moderately elongated; dorsal profile of the head nearly straight; head pointed; Body depth more or less equal to head length; pre-operculum rounded, serrated; eyes big, prominent; dorsal and anal fin soft rays, pectoral and caudal fins rounded.

Body brownish gray to black with numerous large white spots including fins; dark blotches below dorsal fin and caudal peduncle; prominent black streak on maxillary groove.

Cephalophalis miniata **(Forsskål, 1775)**

Coral hind

D XI, 14; A III, 8; P 17; V I, 5; LL 47-56; Gr 7-9+14-16.

Body moderately deep; dorsal profile of the head straight, with convex above eye; maxilla big, crossing the rear edge of eye; eyes small; pre-operculum rounded; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body orange to reddish brown, with small blue spots all over the body including fins; Margin of soft rays of dorsal and anal and caudal fins bluish.

***Anyperodon leucogrammicus* (Valenciennes, 1828)**

Slender grouper

D XI, 14; A III, 8; P 15; V I, 5; LL 61-72; Gr 7-9+14-17.

Body elongated, slightly compressed; head elongated, its length greater than body depth; dorsal profile of the head slightly slopped to straight; eyes moderate; mouth

large terminal; pre-operculum slightly serrated, rounded; interfin membrane of soft rays transparent; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body greenish brown to gray with numerous reddish spots including head and fins; spots in head small; 3 to 4 longitudinal white bands running from mouth to caudal peduncle.

***Cephalopholis argus* (Schneider, 1801)**

Peacock hind

D XI, 16; A III, 9; P 16; V I, 5; LL 46-51; Gr 9-11+17-19.

Body deep; head big, its length 2.4 to 2.7 times in standard length; eyes small; mouth big, terminal to slightly superior; maxilla extends beyond to the level of eye; pectoral fin fleshy; dorsal and anal fin soft rays, pectoral and caudal fins rounded.

Body dark brown with numerous blue to white spots with dark margin; 5 to 6 pale vertical bars on the rear part of body; dorsal fin spines with orange margin; posterior margin of median fins darker with a narrow white tip; pectoral fin with dark brownish to purplish red posterior edge.

***Cephalopholis formosa* (Shaw, 1812)**

Bluelined Hind

D IX, 18; A III, 8; P 15; V I, 5; LL 47-51; Gr 6+15.

Body moderately, deep; dorsal profile of the head slopped with convex inter-orbital; eyes small; maxilla ends at

posterior end of the eye; dorsal and anal fin soft rays, pectoral and caudal fins rounded; body scales ctenoid.
Body dark yellowish brown, fins darker; wavy longitudinal blue lines all over body including head and fins; blue spots on the snout, lower part of head and thorax.

Epinephelus lanceolatus **(Bloch 1790)**
Giant grouper

D XI, 14; A III, 8; P 16; V I, 5; LL 46-51; Gr (9-11)+(17-19).
Body robust in adult and slightly deep in juveniles; dorsal profile of the head slightly convex; eyes small; mouth moderately big, terminal to superior; maxilla reaching rear edge of eye; pre-operculum finely serrated in edges; inter fin membrane of spines notched; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body greyish yellow above, grayish white below and sides with numerous uneven black blotches all over the body; head darker; fins yellowish with black blotches; juveniles with 3 irregular black bars in body, large adults dark brown to grey. This is a protected species under Wild Life (Protection) act, 1972 of India.

Cephalopholis cyanostigma **(Valenciennes, 1828)**
Blue spotted hind

D IX, 15; A III, 8; P 15; V I, 5; LL 46 to 50; Gr 7-9+14-18
Body moderately compressed, deep; dorsal profile of head convex above eye; eyes small slightly projected; mouth large terminal to superior; maxilla vertically reaching the rear edge of the eye; pre-operculum rounded; body scales ctenoid; soft rays of the dorsal and anal fin, pectoral and caudal fin rounded.

Body brown to brownish red, head darker; with numerous black edged bluish spots all over the body including fins; spots in head, chest and belly comparatively big with spots in fins and posterior body; sides with 4 to 5 dark chain like bars; median fins darker than body colour; pectoral fin darker or with black margin at the free tip.

Epinephelus ongus **(Bloch, 1790)**

White streaked grouper

D XI, 14; A III, 8; P 15; V I, 5; LL 48 to 53; Gr 8-10+15-18.

Body comparatively deep; dorsal profile of head steeply sloped, slightly convex above eye; eyes big projected; mouth moderately small; maxilla vertically reaching middle of the eye; head slightly pointed; pre operculum rounded; soft rays of dorsal and anal fins, pectoral and caudal fin rounded.

Body brownish with numerous small white spots all over the body which sometimes forms wavy lines; head darker with less white spots; median fins with small white spots, posterior margin darker with white tip; paired fins greyish brown.

Epinephelus merra **(Bloch, 1793)**

Honeycomb grouper

D XI, 17; A III, 8; P 17; V I, 5.

Body robust, slightly compressed, elongated; mouth superior, large, maxilla exposed, slightly protractile; small, slender teeth on jaws, vomer and palatine; some small canines on front; eyes prominent; dorsal profile of the head sloped; pre-operculum serrated; one flat spine on operculum; small ctenoid scales; pectoral fin like an hand fan; caudal fin rounded.

Body grey above and lighter below; brown to black spots all over the body, hexagonal anteriorly, rounded posterior; fins rays of dorsal and caudal fin yellowish; pectoral and pelvic fins dark brown to black.

Epinephelus flavocaeruleus **(Lacepède, 1802)**

Blue-and-yellow grouper

D XI, 8; A III, 5; P 16; V I, 5; LL 61-74; GR (9-10) + (15-17)

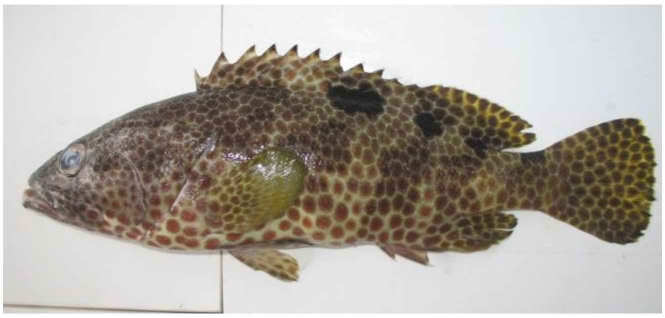
Body deep; dorsal profile convex; eyes small, head length 2.5 in SL; BD 2.5 in SL; nostril top of the eye; mouth inferior;

teeth canine; operculum with undeveloped spines; pre-operculum serrated; interfin membrane of dorsal fin deeply notched; caudal fin truncate; caudal peduncle thick and short. In fresh condition body colour blackish with bright yellow dorsal, anal and caudal fins; outer tip of caudal blackish; in formalin preserved specimens fins are whitish; black tip of caudal fin is retained.

Epinephelus spilotoceps **(Schultz, 1953)**
Four saddle grouper

D XI,17;A III,8;P 17;I,5;LL 60-69;GR (7-8)+(15-18)

Body elongated; pre dorsal profile is slightly convex; eyes small; head length 2.5 in SL; BD 2.5 in SL; mouth inferior; maxillary ends at the middle of the eye; teeth canine; operculum with one developed pine; pre-operculum serrated; pectoral fin origin in front of the pelvic fins; dorsal fin spinous interfin membrane deeply notched; caudal fin truncate; caudal peduncle thick and short.



In fresh condition the body colour is yellowish brown with spot all over the body; in formalin preserved specimens the black spots are light black.

Epinephelus diacanthus **(Valenciennes, 1828)**
Thornycheek grouper

D XI, 15-17; A III, 8-9; P 18-20; VI, 5; Ll 105-120.

Body depth contained 2.8 to 3.2 times in standard length. Pre-opercle border forming nearly a right angle, with 1 to 3 enlarged serrae at the angle; sides of lower jaw with 2 rows of small subequal teeth; anterior nostrils tubular, with a large flap posteriorly extending over rear nostril; lower gillrakers 14 to 16. caudal fin rounded to almost truncate. Pored lateral line scales 53 to 60. Body generally buff, with 5 more or less distinct, vertical dark bars;

4 bars below dorsal fin and 5th on caudal peduncle. Ventral part of head and body reddish. Some specimens with a black streak across cheek at upper edge of maxilla. Dark bars on body sometimes absent.

FIELD IDENTIFICATION OF LUTJANIDS AVAILABLE IN INDIAN WATERS

Dr. Rekha J Nair
Principal Scientist
Demersal Fisheries Division
ICAR-CMFRI, Kochi

Family Lutjanidae – SNAPPERS

Body deep, mouth large, protrusible, anterior part of head without scales; some rows of scales on cheek, pre-opercle and on gill cover.

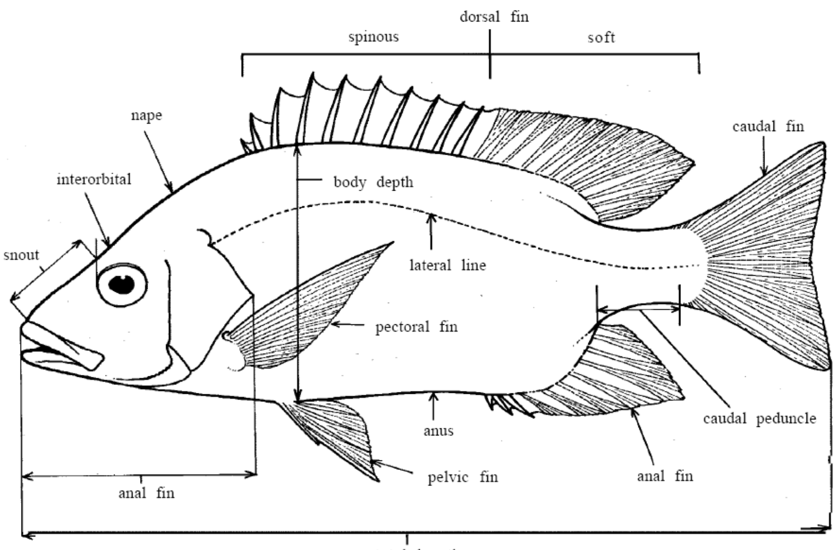
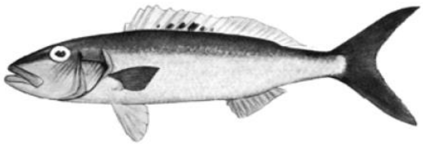
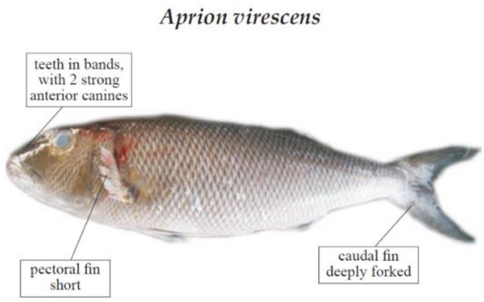


Fig. 4

The Main genera

Aprion





Green jobfish

D X, 11; A III, 8; Gr 14 -15 (lower limb); P 17; Ll 48 -50

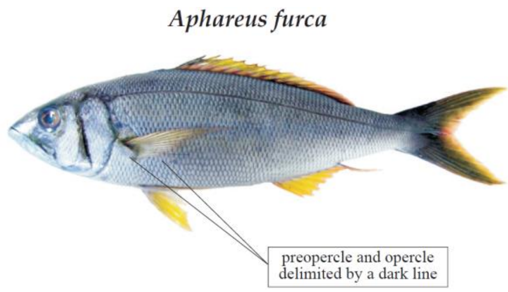
Elongate fish with rounded body; clear horizontal groove in front of eye; teeth in both jaws in bands, with 2 strong canines anteriorly; vomerine tooth patch crescent-shaped. Pectoral fins short, rounded, about equal to snout length; caudal fin deeply forked, lobes pointed; scales absent on dorsal and anal fins. Moderate-sized scales, on lateral line; scale rows on back parallel with lateral line. Body colour dark green to bluish or blue-grey.

Genus Aphaerus

Medium-sized snappers; minute teeth in jaws, canines, vomerine absent; premaxillae not protractile; gill openings extending well forward to front of eye; interorbital space flattened. Continuous dorsal fin, not incised near junction of spinous and soft portions, with 10 spines and 11 soft rays; anal fin with 3 spines and 8 soft rays; pectoral fins long, slightly shorter than head, with 15 - 16 rays; dorsal and anal fins scaleless; caudal fin forked. Scales small, about 65 - 75 in lateral line. Body bluish grey, sometimes with a silvery sheen on lower sides and belly.

Species: *Aphareus furca* (Lacepède 1801)- Small toothed jobfish

D X, 11; A III, 8, P 15 -16, Ll65 -75; Gr 16 -18



Elongate compressed body, with lower jaw protruding; maxilla extending to below middle of eye; interorbital space flattened;

teeth in jaws small, disappearing with age; roof of mouth toothless; scale rows on back parallel with lateral line.

Colour: Back and upper sides purplish-brown; blue-grey on sides; a silvery sheenon head and lower sides; edges of pre-opercle and opercle outlined with black; fins whitish to yellow-brown.

***Aphareus rutilans* -** Rusty jobfish

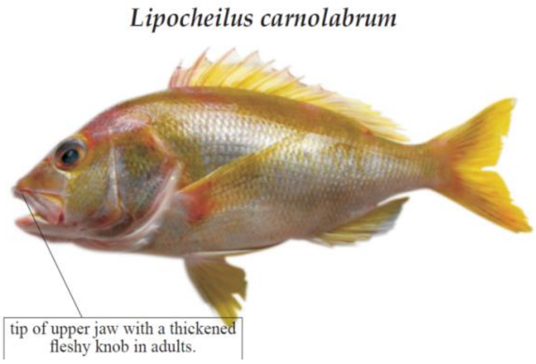
D X, 11; A III, 8, P 15 -16, Ll 70 - 73; Gr 15 - 16

Elongate compressed body, with lower jaw protruding; maxilla extending to below middle of eye; interorbital space flattened; **teeth small, forming narrow uniform band in each jaw**; roof of mouth toothless; gill rakers on lower limb (including rudiments) 30 to 34; scale rows on back parallel with lateral line. Body colour blue-greyish reddish; fins yellowish red, pelvics and anal fin sometimes whitish; margin of maxilla black.

Lipocheilus carnolabrum

D X, 10; A III, 8, P 15 -16, Ll65 -75; Gr 16 -18

Mouth large, adults with a thick, fleshy protrusion at anterior end of upper lip. Vomerine tooth patch V-shaped, without a medial posterior extension; no teeth on tongue. Maxilla scaleless. Interorbital space flattened to convex. Dorsal and anal fins scaleless. Last dorsal and anal soft rays not produced. Pectoral fins long, reaching beyond level of anus. Scale rows on back parallel to lateral line. Upper part of head brown; yellowish or pinkish on sides; a silvery sheen on ventral portion of body.



Upper lip with a median fleshy protrusion, well developed in adults spines of dorsal and anal fins strong, very robust in large adults . . . . ***Lipocheilus carnolabrum***

`

Genus Lutjanus

Small oblong, slender and fusiform sized snappers with relatively deep bodies. Mouth large, protractile; with pointed, conical teeth in jaws arranged in one or more rows, with an outer series of canine teeth, some of which, particularly those at front of jaws, are generally enlarged and fanglike; vomerine tooth patch V-shaped or crescentic, with or without a medial posterior extension, or diamond-shaped; interorbital space convex; pre-opercle serrate, its lower margin with a shallow to deep notch, and opposite portion of interopercle sometimes with a bony knob, most strongly developed in species with a deep pre opercular notch. Dorsal fin continuous, often with a slight notch between the spinous and soft portions, with 10 or 11 spines and, 11 to 16 soft rays; anal fin with 3 spines and 7 to 10 soft rays; pectoral fins with 15 to 18 rays; dorsal and anal fins scaled; caudal fin truncate or emarginate, rarely forked.

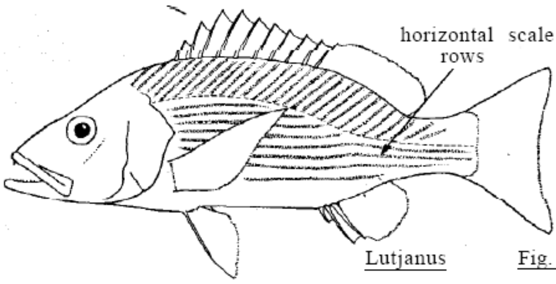


Fig. 13

Colour: Extremely variable, but often consisting of a reddish, yellow, grey, or brown background and a pattern of darker stripes or bars; frequently with a large blackish spot on upper sides below anterior dorsal soft rays.

Key to the genera of Lutjanidae occurring in the area (adapted and modified from FAO)

Notes: Species names are given when a genus includes a single species. Counts of gill rakers include rudiments, if present.

1a**.** Dorsal and anal fins without scales; dorsal fin with X spines and 10 or 11 soft rays ***. 2***

1b**.** Soft dorsal and anal fins with scales or sheathed with scales basally; dorsal fin with X to XII spines and 11 to 19 soft rays ***. 10***

2a. Maxilla with scales ***. 3***

2b**.** Maxilla without scales ***. 5***

3a**.** Spinous portion of dorsal fin deeply incised at its junction with soft portion; dorsal fin with X spines and 11 (very infrequently 10) soft rays ***. . . . . . . Etelis***

3b**.** Spinous portion of dorsal fin not deeply incised at its junction with soft portion; dorsal fin with X spines and 10 soft rays **. . . . . . .** ***4***

4a**.** Last soft ray of both dorsal and anal fins shorter than next to last soft ray **. . . . . . .** ***Paracaesio***

5a**.** Premaxillae essentially not protrusible, attached to snout at symphysis by a frenum **. . . . . . .** ***6***

5b**.** Premaxillae protrusible, not attached to snout by frenum **. . . . . . .** ***7***

6a**.** Vomer without teeth (small juveniles may have minute teeth on vomer); teeth in jaws very small, no caniniform teeth; pectoral fins somewhat shorter than head; lateral surface of maxilla smooth **. . . . . . .** ***Aphareus***

7a. Dorsal fin with X spines and 11 (rarely 10) soft rays; last soft ray of both dorsal and anal fins longer than next to last soft ray **. . . . . . .** ***8***

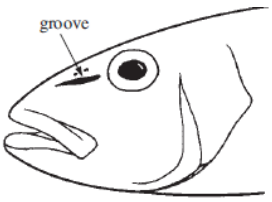
7b**.** Dorsal fin with X spines and 10 soft rays; last soft ray of both dorsal and anal fins shorter than next to last soft ray **. . . . . . .** ***9***

8a. Groove present on snout below nostrils; pectoral fins less than 1/2 length of head **. . . . .** ***Aprion virescens***

8b**.** No groove on snout; pectoral fins a little shorter than head to somewhat longer than head **. . . . . . .** ***Pristipomoides***

9a**.** Upper lip with a median fleshy protrusion, well developed in adults spines of dorsal and anal fins strong, very robust in large adults **. . . . . . .** ***Lipocheilus carnolabrum***

9b**.** Upper lip without a median fleshy protrusion **. . . . . . .** ***Paracaesio***



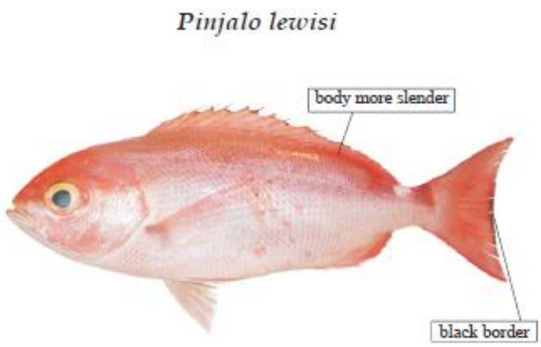
Paracaesio ***Lipocheilus***

10**.** Vomer with teeth; dorsal fin with X to XII spines and 11 to 16 soft rays; none of anterior soft dorsal-fin rays produced as filaments **. . . . . . .** ***11***

11a. First gill arch with 60 or more gill rakers on lower limb . . . . ***Macolor***

11b. First gill arch with 20 or fewer gill rakers on lower limb ***12***

12a. Upper and lower profiles of head equally rounded; eye set toward middle of head; mouth rather small, somewhat upturned; no fang-like canines at anterior ends of jaws . . . . ***Pinjalo***



12b. Upper and lower profiles of head not equally rounded, upper profile evenly rounded to steeply sloped, and lower profile flattened; eye closer to upper profile of head than to lower; mouth larger, usually not upturned; some fang-like canines usually present at anterior ends of jaws . . . . ***Lutjanus***

Key to the species of *Aphareus* occurring in Indian waters

Remark on key character: counts of gill rakers include rudiments, if present.

1a. First gill arch with 6 to 12 gill rakers on upper limb and 15 to 18 on lower limb (total 22 to28); colour of body varying from steel blue to purplish brown . . . . ***Aphareus furca***

1b. First gill arch with 16 to 19 gill rakers on upper limb and 32 to 35 on lower limb (total 49 to 52); colour of body varying from blue-grey or mauve to . . . . ***Aphareus rutilans***

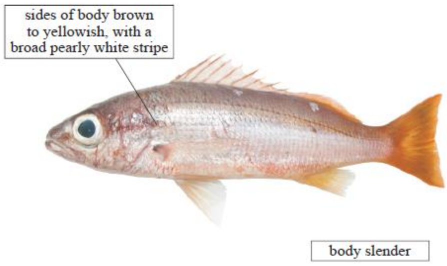
Key to the species of *Etelis* occurring in Indian waters

1a. Total gill rakers on first gill arch 17 to 22. . . . . . . ***Etelis carbunculus***

1b. Total gill rakers on first gill arch 23 to 36 upper lobe of caudal fin longer. ***2***

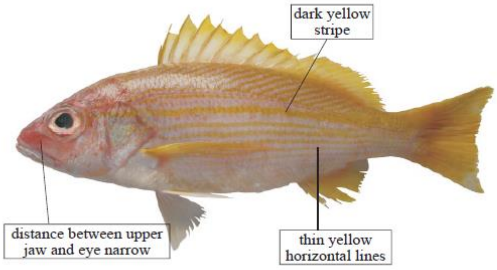
Key to the Indo-Pacific species of *Lutjanus (modified from FAO)*

l. Pre-orbital space (distance between upper jaw and eye) very narrow, body slender, dorsal spines usually 11, soft dorsal rays 12.



Body depth 3.5 to 3.8 times in standard length; tongue without teeth; a dark band from snout to caudal fin base and two pearly spots above lateral line, soft portion of dorsal fin ***L. biguttatus***

Body depth 2.9 to 3.3 times in standard length; tongue with a patch of fine granular teeth; colour generally silvery-white with a broad yellow stripe along middle of side to caudal fin base and narrow yellowish lines, corresponding with longitudinal scale rows (eastern Africa to western Pacific) . . . . ***Lutjanus lutjanus***



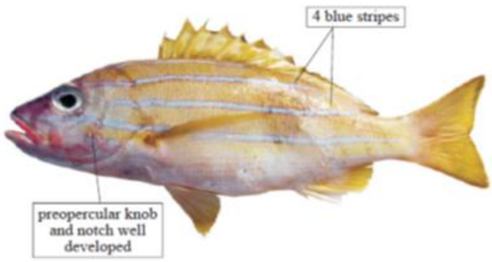
3a. Yellow coloured body with a series of 4 or 5 longitudinal blue stripes on sides which become brown when preserved.

3b. Colour not as above **6**

4a. Dorsal-fin spines XI or XII . . . . ***Lutjanus bengalensis***

4b. Dorsal-fin spines X **5**

5a**.** Four stripes on side, with white whitish belly sometimes with thin grey lines; scale rows on cheek 5 or 6; upper pectoral-fin rays darkish . . . . . . ***Lutjanus kasmira***



5b. Five stripes on side, belly not whitish, thin lines absent; scale rows on cheek

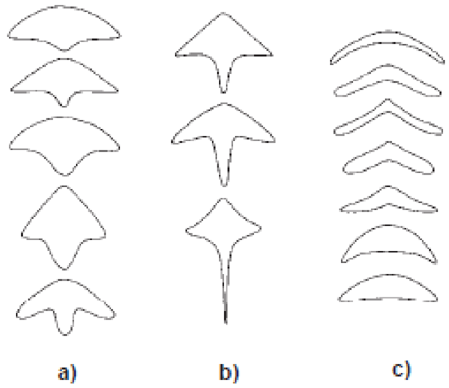
10 or 11; upper pectoral-fin rays pale . . . . ***Lutjanus quinquelineatus***

6a. Longitudinal scale rows above lateral line obliquely positioned**.** **7**

6b. Longitudinal scale rows above lateral line entirely horizontal or some rows rising obliquely from below middle part of dorsal fin . . . .

7a. Vomerine tooth patch triangular or diamond-shaped with a medial posterior extension **8**

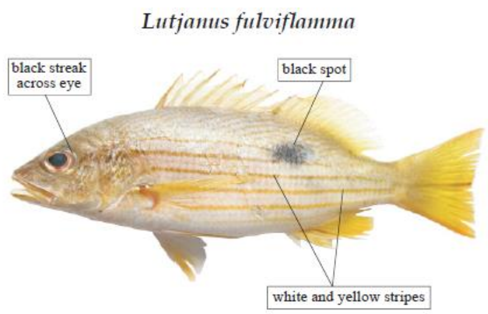
7b. Vomerine tooth patch crescentic to triangular without a posterior extension . . . **11**



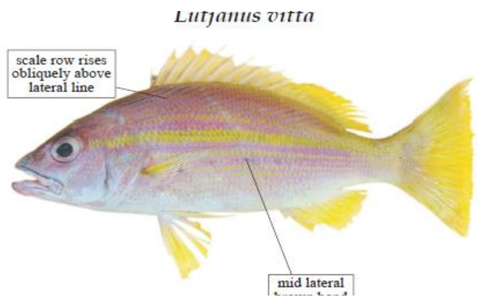
Shapes of the vomerine tooth patch

8a**.** Soft dorsal-fin rays usually 14; a relatively wide gap between temporal scale bands of each side; spot on upper side situated mainly above lateral line; young specimens with series of 4 to 7 broad stripes (blackish to orange or yellow-brown in life) on side, these persisting as thin stripes in adults from the western Indian Ocean . . . . ***Lutjanus russelli***

8b**.** Soft dorsal-fin rays usually 13; little or no gap between temporal scale bands of each sidespot on upper side situated mostly below lateral line or bisected by it, spot sometimes very elongated; young specimens without series of 4 to 7 broad dark stripes on side . . . . ***Lutjanus fulviflamma***



9a**.** Mid-lateral stripe usually broader and darker than other stripes on side; transverse scale rows on cheek 7 to 10 . . . . ***Lutjanus vitta***

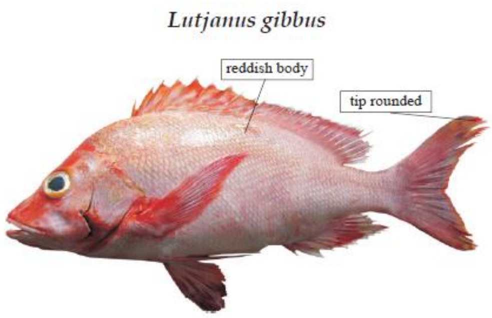


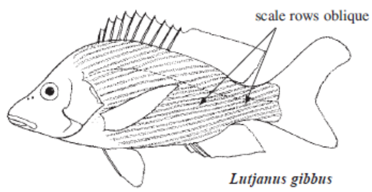
9b**.** Mid-lateral stripe not broader or darker than other stripes on side, yellow in life and faint or absent in preserved specimens; transverse scale rows on cheek usually 6 or 7(occasionally 8) ***12***

10a**.** Predorsal scales extending to mid-interorbital level; a blunt, flattened spine on upper margin of opercle, above the main centrally located spine; interorbital width 4.4 to 6.5 in head length; total gill rakers on first gill arch (including rudiments) 18 to 21 **. . . . . . . *Lutjanus madras***

11**.** Total gill rakers (including rudiments) on first gill arch (including rudiments) 25 to 30 **. *12***

12. Dorsal fin with X spines and 13 or 14 soft rays; scale rows below lateral line ascending obliquely caudal fin distinctly forked with rounded lobes; colour deep red to grey, fins red or dark brown to blackish **. . . . . . . *Lutjanus gibbus***





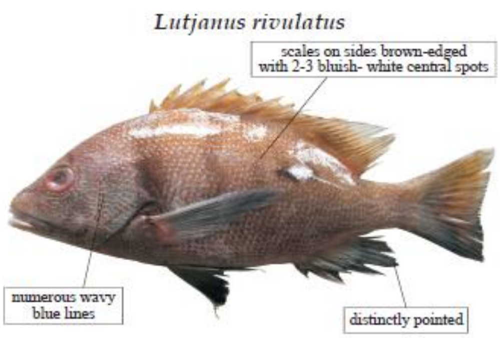
13a**.** Soft anal-fin rays 10; dorsal fin with XI spines and 16 rays; colour pattern consisting of 3 dark brown to red transverse bars (may be indistinct in large adults) **. . . . . . . *Lutjanus sebae***

13b**.** Soft anal-fin rays 8 or 9; dorsal-fin elements variable, the fin with X or XI spines and 12 to 16 soft rays; colour not as above **. *14***

14a. Pre-opercular notch distinctive (moderately to well developed**. 15**

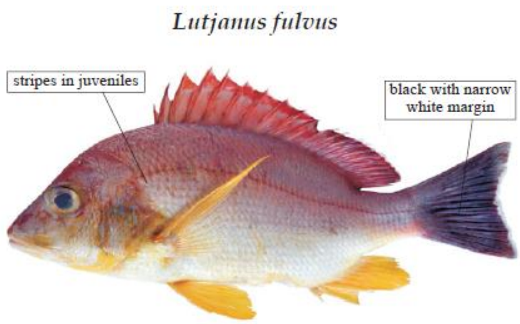
14b. Pre-opercular notch not distinct **. 21**

15a. Soft dorsal-fin rays 15 or 16; body relatively deep, 2.1 to 2.4 times in standard length; head usually with numerous wavy lines (bluish in life); a chalky spot often present below junction of spinous and soft parts of dorsal fin, bordered with black in juveniles, but lost with age; lipsthick in large adults **. . . . . . .*Lutjanus rivulatus***



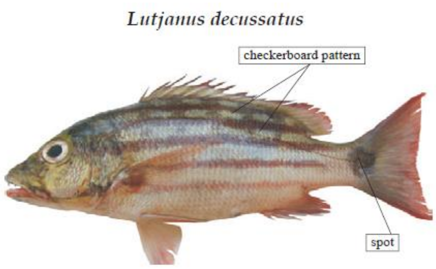
15b. Soft dorsal-fin rays 13 or 14; body usually more slender, 2.3 to 2.8 times in standard length; colour not as above; lips not thick in adults **. 16**

16a. Caudal fin and distal third of dorsal fin blackish or dusky brown with a narrow white border . . . . ***Lutjanus fulvus***

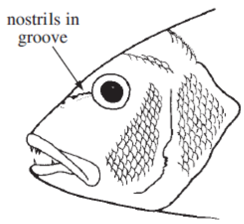


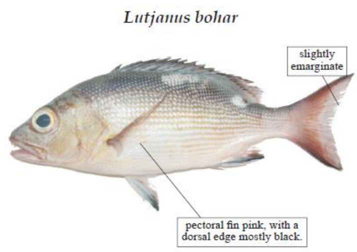
16b. Caudal fin yellow or grey basally and yellow distally without narrow white border; distal third of dorsal fin not noticeably darker than remainder of fin . . ***17***

17a. Colour pattern consisting of a series of 5 dark stripes on whitish ground colour; 2 or 3 uppermost stripes crossed by dark vertical bars forming a network of light and dark squares; a large dark spot at base of caudal fin . . . . ***Lutjanus decussatus***

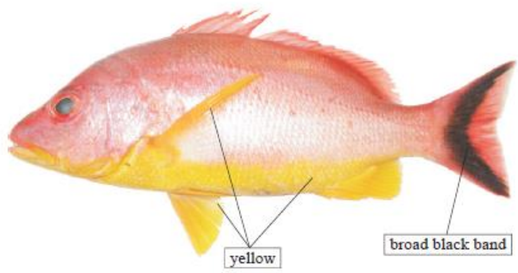


17b. Two whitish spots on upper back, anterior spot below last 4 dorsal-fin spines and posterior one under last 6 dorsal-fin rays and meeting that of other side across top of caudal peduncle; colour brown on upper back grading to tan or light brownish ventrally; dorsal and caudal fins dusky; outer portion of anal and pelvic fins distinctly blackish; upper third of pectoral fins dusky brown; tongue with a patch of fine granular teeth . . . . ***Lutjanus bohar***





18a. Caudal fin with a distinctive crescentic black marking, remainder of body and fins uniformly yellowish tan (yellow in life) with a silvery sheen on lower sides . . . . ***Lutjanus lunulatus***



18b. A black spot on upper side at level of lateral line below soft dorsal fin; rest of body and fins mainly pale; tongue with a patch of find granular teeth, although sometimes absent in juveniles . . . . ***Lutjanus monostigma***

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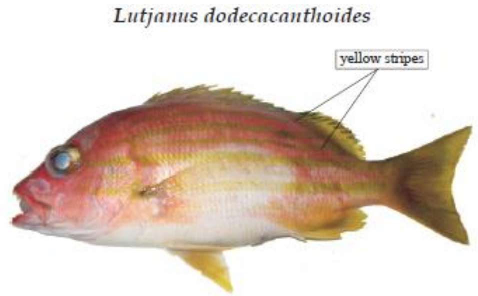
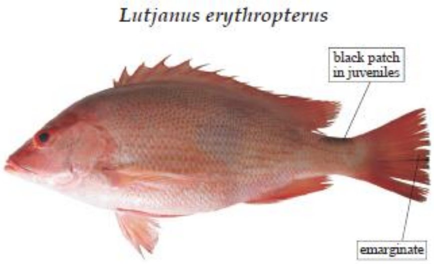
19a 

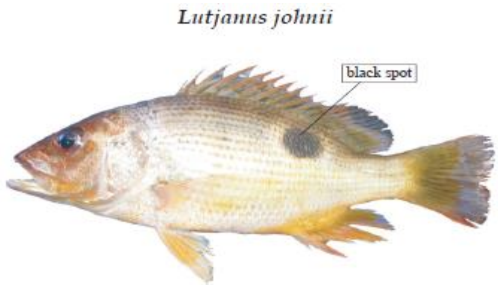
Dorsal-fin spines XII; 5 - 6 yellow stripes; longitudinal rows of scales below lateral line which rise . . . . ***Lutjanus dodecacanthoides***

19b Small mouth, length of maxilla less than distance between bases of last dorsal- and anal-fin rays some longitudinal scale rows below lateral line slanting obliquely in posterior direction toward dorsal profile; convex head profile . . . . ***Lutjanus erythropterus***

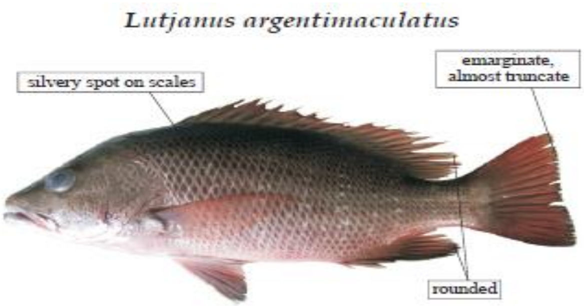


20a**.** Triangular vomerine tooth patch with medial posterior extension; narrow preorbital space, large prominent black spot, bisected by the lateral line below posterior part of spinous dorsal fin . . . . ***Lutjanus ehrenbergii***

21 A large black spot on upper back ground colour pale, each scale on side often with a brownish spot forming longitudinal rows on side . . . . ***Lutjanus johnii***



22 Body depth 2.5 to 2.9 times in standard length; least depth of caudal peduncle 3 to 3.5 times in head length; longitudinal scale rows on upper back parallel to lateral line anteriorly and some rows usually ascend obliquely below posterior dorsal fin spines . . . . ***Lutjanus argentimaculatus***



Key to genus *Macolor* species occurring in Indian waters (modified from FAO)

1a**.** First gill arch with 37 - 42 gill rakers on upper limb and 71 - 81 on lower limb (total 110 to 122); anal fin with III spines and 10

soft rays; long pointed pelvic fins in juveniles and short rounded pelvic fins in adults . . . . ***Macolor macularis***

Key to the species of *Paracaesio*

1a. Body dark purplish brown, with violet lines on body . . . . ***Paracaesio sordida***

3b. Caudal fin, upper part of caudal peduncle, and upper side of body to anterior end of dorsal fin yellow; rest of body mostly blue; pre-opercle almost always without scales . . . . ***Paracaesio xanthura***

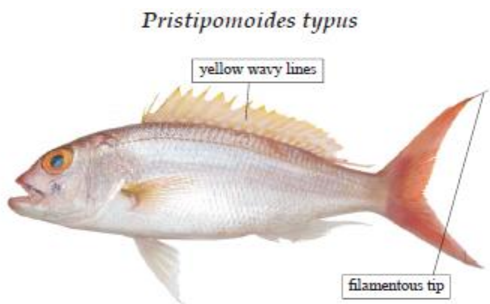
Key to the species of *Pristipomoides* occurring in Indian waters

1a. Lateral-line scales 48 to 50 . . . . ***2***

1b. Lateral-line scales 57 to 74 . . . . ***3***

2a. Two golden stripes bordered with blue on snout and cheek; transverse vermiculations on top of head. . . . . . . ***Pristipomoides multidens***

2b. Golden stripes absent on snout and cheek; longitudinal vermiculations on top of head present . . . . ***Pristipomoides typus***

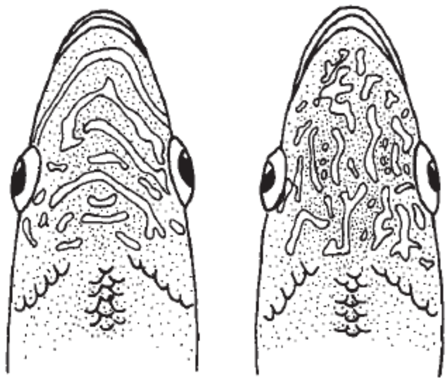


3a. Gill rakers on first gill arch 27 - 33; 67 to 74 lateral-line scales. ***4***

3b. Gill rakers on first gill arch 17 to 27; 57 to 67 lateral-line scales. ***5***

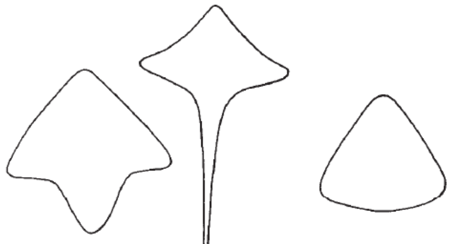
4a. Backward prolongation in midline for the vomerine tooth patch; tongue with patch of teeth . . . . ***Pristipomoides sieboldii***

4b. Vomerine tooth patch triangular backward prolongation absent; teeth absent on tongue . . . . ***Pristipomoides auricilla***



a) *Pristipomoides multidens* b) *Pristipomoides typus*

Dorsal view of head



a) *Pristipomoides sieboldii* b) *Pristipomoides auricilla*

Vermiculations on head

5a. Lateral-line scales 63 to 67; side of body with alternating oblique red and yellow bars . . . . ***Pristipomoides zonatus***

5b. Total gill rakers on first gill arch 22 to 27; lateral-line scales 57 to 63; side of body without red and yellow bars; caniniform teeth at anterior ends of jaws. . . . . ***Pristipomoides filamentosus***

Pristipomoides filamentosus

Fishery and biology of commercial penaeid shrimps

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Marine shrimps are fished all along the Indian coast and brought to different fish landing centres/harbours located in the maritime states. They are caught mainly by trawlers, either multiday or single day trawlers using trawl nets. The multiday trawling operations may extend from three days to more than a week. The voyage by single day trawlers is restricted to 6 to 7 hours. There are several commercially important shrimp species in India– *Penaeus indicus, Metapenaeus dobsoni, Metapenaeus monoceros, Metapenaeus affinis, Parapenaeopsis stylifera, Penaeus semisulcatus, Penaeus monodon, Solenocera choprai* etc. In each maritime state, the species composition varies and one or the other species may dominate the landings in quantity. Some of them are highly valued in the international markets whereas others are utilised for domestic consumption. Certain smaller species are also dried and consumed. In India the total peaneid shrimp landings during 2016 was 200116 t forming 45% of the crustacean and 12% of the total marine landings.

Diagnostic characters provide identity to each species and species having similar or certain identical characters are placed under same genus and family. Commercial shrimp species mostly belong to the family penaeidae, under the genera *Penaeus, Metapenaeus, Parapenaeopsis, Metapenaeopsis, Solenocera* and *Trachypenaeus*.

Almost all the marine shrimps have an estuarine phase in their life cycle, that is they spend a part of their life in the estuaries or backwaters. The adults breed offshore while post larvae and juveniles are estuarine. They have an offshore planktonic larval phase, estuarine benthic postlarval, juvenile phase and an inshore adult and spawning phase (Dall et al., 1990). Postlarvae move towards the coast and enters estuaries and mangrove swamps that serve as nursery grounds. An exception to this is found in *Parapenaeopsis stylifera* which spends its entire life cycle in the sea. Some of the important estuaries in India are: Hoogly-Matlah in West Bengal, Mahanadi & Chilka Lake in Orissa, Godavari & Krishna in Andhra Pradesh, Vellar & Killai backwaters and Pulicat Lake in Tamil Nadu, Cochin backwaters & Vembanad Lake in Kerala; Narmada-Tapthi and Little Rann of Kutch in Gujarat

Size at maturity differs based on species and geographical area. Depending on the colour and size of the ovary, five maturity stages have been identified in penaeid shrimps – immature (IM), early maturing (EM), late maturing (LM), mature (M) and spent (SP). Females are usually larger in size compared to males. Females can be identified externally by the secondary sexual character thelycum and males by the petasma. They have high fecundity and are carnivorous. They have a life span of around 2 to 2.5 years, spawning throughout the year with peaks in spawning.

Further reading:

FAO species identification sheets. 1983. Fishing Area 51(Western Indian Ocean), 190 pp.

FAO species identification sheets for fishery purposes. 1998.The living marine resources of the western Central Pacific. Volume 2. Cephalopods, crustaceans, holothurians and sharks, 687 – 1396 pp.

E.V. Radhakrishnan, Josileen Jose and S.Lakshmi Pillai (eds). 2011. Handbook of Prawns. Central Marine Fisheries Research Institute, Kochi-18 125 pp.

Motivational Skills and Personal Effectiveness

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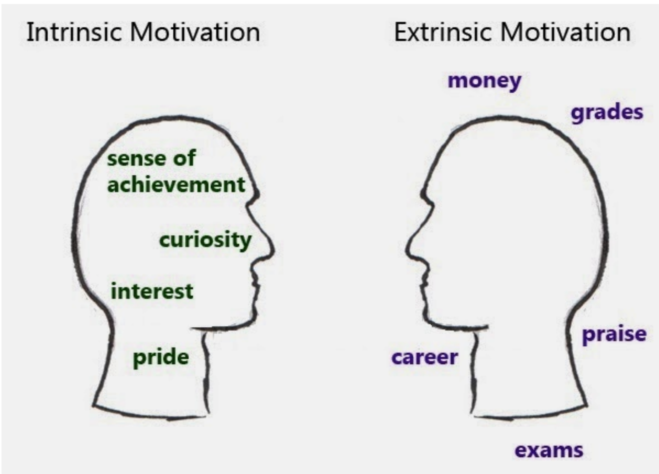
'A great man is the one who can make a small man feel great, and perform great'

The man greatness is simply determined based on his motivational skills. Motivation is the word derived from the word 'motive' which means needs, desires, wants or drives within the individuals. It is the process of stimulating people to actions to accomplish the goals. In the work goal context the psychological factors stimulating the people's behaviour can be the desire for money, success, recognition, job-satisfaction, team work, etc.

One of the most important functions of management is to create willingness amongst the employees to perform in the best of their abilities. Therefore the role of a leader is to arouse interest in performance of employees in their jobs. The process of motivation consists of three stages. A felt need or drive, a stimulus in which needs have to be aroused and when needs are satisfied, the satisfaction or accomplishment of goals. Therefore, we can say that motivation is a psychological phenomenon which means needs and wants of the individuals have to be tackled by framing an incentive plan. In the general motivational process, there is a need, drive and a particular goal.

There are two types of motivation. Extrinsic motivation from outside, often from rewards and Intrinsic motivation within the individual based on sense of achievement, curiosity, interest and pride.



Personal Effectiveness

The motivational sills of a person give rise to his effectiveness. Let's look into what effectiveness means? The word 'effectiveness' differs significantly from the word 'efficiency'. Effectiveness means 'doing the right thing' and efficiency refers to 'doing things rightly'. Both are almost appearing to be synonymous, but indeed there are a couple of differences. Any way for human beings, we normally use the terminology of effectiveness. Efficiency is a terminology generally used for machines. Here are some glimpses of personal effectiveness. Have a glance of the following remarks and the corresponding persons who really created a difference and made their presence remarkable due to their personal effectiveness.

- *A small boy-the fifth amongst the seven siblings of a poor father, as selling newspapers in a small village to earn his living. He was not exceptionally smart at school nut was fascinated by religion and rockets. The first rocket he built crashed. A missile built crashed multiple times and he was made a butt of ridicule. He was the person to have scripted the space Odyssey of India single –handedly and later who became the honorable Indian President……. He was* **Dr. A.P.J Abdul Kalam.**

- *A man failed in business at age 21; was defeated legislative race at 22; failed again in business at 24; Overcame the death of his sweetheart at 26; Met with a nervous breakdown at 27; Lost congressional race at 34; Lost senatorial race at 45; failed in vice-president contestation at 47; Lost senatorial race at 49; finally won to be President of United States at 52 ……..and he was …………***Abraham Lincoln**

- *A candidate for a news broadcasters post was rejected because of his voice. He was also told that with his obnoxiously long name, he would never be famous……………He is* **Amitabh Bachan**

- *When a gentleman invented a communications machine in 1876, it did not ring off the hook with calls from potential backers. After making a demonstration call, President Rutherford Hayes said, "That's an amazing invention, but who would ever want to see one of them? He said this to a person who made maximum inventions in the world and was none other than…………***Alexander Graham Bell**

- *An ordinary man took up a number of odd jobs including being a carpenter and a coolie. He was later employed as a bus conductor. He then began to take part in stage plays. A famous Tamil film director accidentally noticed him and gave a chance in a Tamil cinema where he played a supporting role. The movie was well received and went on to win three National Awards. Later he became the evergreen superstar in Tamil…………….***Rajinikanth**

- *A 4 year old girl, the 20th of 22 children, contracted double pneumonia and scarlet fever at a very early age, which paralysed her left leg. Thereafter at 9 years of age she removed her leg braces and started walking without them. At 13, she decided to become a runner but kept failing miserably in all races that she entered in. She kept trying in spite of several detractors and finally started winning every race she entered and became the winner of 3 Olympic gold medals. She is ……………………….***Wilma Rudolph**

- *Born in India. His father was a teacher and his family didn't have money. He travelled with his family to Yemen at the age of 16 where he started his first job. After some time,he returned to India and founded his first company but things didn't go well. He was above thirty when he started his second company. Shortly his new brand became popular and within years he became a billionairechosen to be among the top business men in Asia and his financial empire today is worth more than 60 billion dollars………….***Dhirubhai Ambani**

- *A school teacher scolded a boy for not paying attention to his mathematics and for not being able to solve simple problems. She told him that he would not become anybody in life. His mother however believed in him and coached him Maths. The boy went on to become ……………………***Albert Einstein**

The above motioned magnificent personalities were the ones who never failed, but who never quitted and proved themselves to be personally effective.The average life span of a human being is 70 years i.e. 26, 500 days and in this period he consumes 60 tons of food and he breaths 23,800 times a day on an average. After finishing every breath we have to realize we are approaching graveyard. So can't we think of something productive to be done by creating a difference to improve our personal effectiveness? The most important prerequisite for improving personal effectiveness is the necessity for a self-change.

Let's quickly have the essence of education. Education is a social process or growth in the sense of producing desirable changes in the behavioral components of human behavior, the behavioral components include knowledge, skill and attitude. There are three things to be changed for a self-change, inevitably and they are our attitude, thinking and behavior. Components of education are teaching and learning. How we are learning? We know it is by sensory techniques. It has been proved that the comprehension though learning is like this. Reading 10 %, Hearing 20 %, Seeing 30 %, Seeing and Hearing 50 % and Doing 90 %.

Being positive in a tough work environment

We have to be aware of a couple of bullets in the surrounding environment. They are Negative work environment, other people's behavior, Negative world view, changing environment, past experience and Determination theory. Let's look into each of these bullets.

A Totally Negative work environment

In a negative work environment, we can encounter these sorts of experiences.

- Dog eats dog . . . everyone fighting to get ahead
- No one appreciates your contributions
- Too much work . . . not enough help
- Deadlines are unrealistic
- Longer hours . . . additional work
- Budget Constraints
- Competition is eating us alive
- Poor management / direction
- Job insecurity
- Donkey Works

Behaviour of other People

We can observe these types of personalities around us. Bulldozers, Complainers, Gossipers, Patronizes, Whiners, Snipers, Backstabbers, Controllers, Snuffers, Exploders, Hypocrites etc. who make out daily routine miserable.

Changing environment

There is a widely accepted quotation that *"The only person who always likes change is a wet baby"*. This is essentially because of the following aspects concerned with change.Thechange***c***hallenges our paradigms. It alters the way we think. It makes life more difficult for a while. It causes Stress. But we have to realize and accept an inevitable truth that Change is an ongoing fact of life.

Past experience

The past experience also might have created a story in our mind. This story will lead to another story and that will lead to another one which in turn makes everything a confusing mesh, which won't make realize the difference between fact and interpretation. Past is only to be refereed for future prospects and never live in the past.

Negative world view

Speaking the context of negative world view, a recent Statistic says crime down 20% in America is being reported up to 600%. Because the trend is to create sensationalisation.Look at what you are looking at! People are bothered on sensational news as the general view of the world itself has become negative. The front page of the newspapers gives the indication that to what extent people are bothered on sensational items.

Determination theory

The determinism theory makes us conclude certain items that it is none of our faults and we find excuses of our own mistakes with justification that those are due to these genetic, psychic or environmental aspects.

- **GENETIC:** My Grandparents did it to me. (Inherited traits)
- **PSYCHIC:** My Parents did it to me. (Upbringing)
- **ENVIRONMENTAL:** My Teacher, My Spouse, My Boss, the Company, the Economy, etc..is doing this to me. (Surroundings)

A pertinent question arsing concerned to Life:

"Are some people just born positive thinkers...........or is it their CHOICE?" We have two luggage here. Our task is to choose the Choose the Right Luggage: We have to either dodge bullets or wear the bullet proof armor. The problem with dodging bullets is 'You*'re definitely going to get hit!* Choice 2 is wearing a bulletproof armor. Wearingthe bulletproof armorcomes from 'SELF CHANGE'.So while putting on the armor. We have to change 3 Things! Attitude, Behaviour and Thinking.

How can we change our Attitude?

Now comes the relevance of the major crux of the topic: the 'Attitude.' Attitude is the positive or negative affect towards a psychological object. Attitude change happens personally from the inside out. So we have to accept our responsibility that I am responsible for who I am, for what I have and for what I do. Second step is to take control over our ownerships, values, mission and discipline.

How can we change our Thinking?

Changes in thinking come from observing logically in every situation. For that we have to observe our thinking and manage our self-talk. Henry Ford's quotation is 'If you think you can, or you think you can't...you're right'. When you get up in the morning, just feed your sub-conscious mind that, this is going to be a wonderful day! Automatically it can be ensured that entire activities will lead to a positive mental stage bringing about a fruitful day. Instead, when you get up and feed your sub-conscious mind that this is going to be a crappy day!, entire activities will become negative leading to a totally embarrassing situation.

How can we change our Behaviour?

This is a million dollar question. Telling how to change is easy, but very difficult to practice. Behaviour changes take true assessment, determination & discipline. For this we have to go for a paradigm shift from the normal reactive behaviour to a proactive/ responsible behavior. Reactive behaviour is just the normal stimulus-response behaviour. But in Proactive behaviour, in between the stimulus and response, there is 'our choice'. Untiring perseverance is required to change our habits and behaviour. Four unique human endowments are Self-Awareness, Imagination, Conscience and Independent Will.

What are the Steps towards Changing Behavior?

This can be explained with an example of learning Car Driving.

1. Unconscious Incompetence: A boy in his childhood doesn't not what a car is and what driving is. He is unconscious and incompetent to drive a car.
2. Conscience Incompetence: As the boy grows, he knows what a car is. But not competent to drive.
3. Conscious Competence: Slowly when he learns driving skill, he is conscious about car driving and is very careful in driving without any distraction as he is consciously competent.
4. Unconscious Competence: In the final stage after expertise in car driving, he drives systematically while he talks or wave as if he is unconsciously competent in car driving. Out entire deeds and activities should reach to this stage for personal effectiveness to emerge as a new personality.

So influence your environment by adding positive behaviour.

- Replace the bad habits!
- Spread a SMILE around
- Sprinkle some "positive" on the "negatives"
- Focus on the good of each day
- Stay out of the "feeding frenzies"
- Say "please" and "thank you"
- Practice *EMPATHY*
- Evaluate *YOUR*behaviour
- Never miss an opportunity to complement
- Before you say anything to anyone, ask yourself three things: Is it true? 2. Is it harmful? 3. Is it necessary?
- Keep promises
- Have a forgiving view of people
- Keep an open mind with changes
- Count to 100 if necessary
- See criticism as opportunity to improve
- Cultivate your sense of humour

Relationship between Attitude and Behaviour

The effect of attitudes on behavior is a growing research enterprise within Psychology. IcekAjzen has led research and helped develop two prominent theoretical approaches within this field: the theory of reasoned action and, its theoretical descendant, the theory of planned behavior. Both theories help explain the link between attitude and behavior as a controlled and deliberative process.

Theory of reasoned action

The theory of reasoned action (TRA) is a model for the prediction of behavioral intention, spanning predictions of attitude and predictions of behavior. The subsequent separation of behavioral intention from behavior allows for explanation of limiting factors on attitudinal influence. The theory derived from previous research that started out as the theory of attitude, which led to the study of attitude and behavior. The theory was "born largely out of frustration with traditional attitude–behavior research, much of which found weak correlations between attitude measures and performance of volitional behaviors".

Theory of planned behavior

The theory of planned behavior was proposed by Icek Ajzen in 1985 through his article "From intentions to actions: A theory of planned behavior." The theory was developed from the theory of reasoned action, which was proposed by Martin Fishbein together with Icek Ajzen in 1975. The theory of reasoned action was in turn grounded in various theories of attitude such as learning theories, expectancy-value theories, consistency theories, and attribution theory. According to the theory of reasoned action, if people evaluate the suggested behavior as positive (attitude), and if they think their significant others want them to perform the behavior (subjective norm), this results in a higher intention (motivation) and they are more likely to do so. A high correlation of attitudes and subjective norms to behavioral intention, and subsequently to behavior, has been confirmed in many studies. The theory of planned behavior contains the same component as the theory of reasoned action, but adds the component of perceived behavioral control to account for barriers outside one's own control.

Have a look at a very interesting quotation '*Watch your definitions……they become thoughts, Watch your thoughts……….. They become words, Watch your words ………. they become actions, Watch your actions………..they become your destiny.'*
The choice is yours, i,e with a bad attitude, we can never have a positive day and with a positive attitude, we can never have a bad day.

Choose POSITIVE Living.
When you have two choices in a natural motivator's case study, the choice you opt will decide your behaviour.
"Each morning I wake up and say to myself, I have two choices today. I can choose to be in a good mood or I can choose to be in a bad mood."
"I always choose to be in a good mood."
"Each time something bad happens, I can choose to be victim or I can choose to learn from it".
"I always choose to learn from it."
'Every time someone comes to me complaining, I can choose to accept their complaining or I can point out the positive side of life'.
'I always choose the positive side of life'.
So 'Life is all about choices. When you cut away all the junk every situation is a choice".

- You choose how you react to situations.
- You choose how people will affect your mood.
- You choose to be in a good mood or bad mood.
- It's your choice how you live your life.

I chose it, because I chose it ……Be happy………

These positive changes in thinking, attitude and behaviour are inevitable for leadership. Leadership is to be observed in a broader perspective compared to management. Because management consists of planning, organizing, leading and controlling and is obvious that leadership is one of the functions of management. It is the degree to which a person can influence other people's behaviour in a desirable way. Inculcating this leadership quality is of paramount significance for personal effectiveness. For that a paradigm shift to a proactive behaviour is mandatory. In the proactive model, our choice is there between the stimulus and response and this freedom to choose is based on our self-awareness, imagination, conscience and independent will.

Here are some of the habits of highly effective people.

- **Be Proactive**: Proactive people take responsibility for their own lives. They determine the agendas they will follow and choose their response to what happens around them. On the contrary, Reactive people don't take responsibility for their own lives. They feel victimized, a product of circumstances, their past, and other people. They do not see as the creative force of their lives.

- **Begin with the End in Mind**: These people use personal vision, correct principles, and their deep sense of personal meaning to accomplish tasks in a positive and effective way. They live based on self-chosen values and are guided by their personal mission statement. But those beginning with no end in mind, lack personal vision and have not developed a deep sense of personal meaning and purpose. They have not paid the price to develop a mission statement and thus live life based on society's values instead of self-chosen values.

- **Put First Things First**: These people exercise discipline, and they plan and execute according to priorities. They also "walk their talk". On the other hand, those putting second things first are crisis managers who are unable to stay focused on high-leverage tasks because of their preoccupation with circumstances, their past, or other people. They are caught up in the "thick of thin things" and are driven by the urgent.

- **Think Win-Win**: These people have an abundance mentality and the spirit of cooperation. They achieve effective communication and high trust levels in their emotional bank accounts with others, resulting in rewarding relationships and greater power to influence. But those thinking Win-Lose or Lose-Win, have a scarcity mentality and see life as a zero-sum game. They have ineffective communication skills and low trust levels in their emotional bank accounts with others, resulting in a defensive mentality and adversarial feelings.

- **Seek First to Understand, then to Be Understood**: Through perceptive observation and empathic listening, these non-judgmental people are intent on learning the needs, interests, and concerns of others. They are then able to courageously state their own needs and wants. But those seeking first to be understood,put forth their point of view based solely on their auto-biography and motives, without attempting to understand others first. They blindly prescribe without first diagnosing the problem.

- **Synergize**: Effective people know that the whole is greater than the sum of the parts. They value and benefit from differences in others, which results in creative cooperation and team-work. . Ineffective people believe the whole is less than the sum of the parts which ultimately results in compromise, fight or flight. They try to "clone" other people in their own image. Differences in others are looked upon as threats.

- **Sharpening the Saw**: Effective people are involved in self-renewal and self-improvement in the physical, mental, spiritual, and social-emotional areas, which enhance all areas off their life and nurture the other six habits.Ineffective people fall back, lose their interest, and get disordered and they wear out the saw. They lack a program of self-renewal and self-improvement and eventually lose the cutting edge they once had.

A glimpse on motivational skills and personal effectiveness are given in this article as tips and by inculcating these habits through untiring perseverance, our intrinsic and extrinsic motivational skills and personal effectiveness can be improved to a great extent. However, it is purely in our hands to make use of our potential to the optimum possible extent.

Marine biodiversity in India

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February 21, 2018

Convention on Biological Diversity

UNEP

Biodiversity is defined by the Convention on Biological Diversity (CBD) as the variability among living organisms from all sources including , among others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species , between species and of ecosystems.

Species diversity
Genetic diversity
Ecosystem diversity

Conservation of biological diversity, its sustainable use and the equitable sharing of its benefits are the main objectives of the convention on Biological Diversity.

192 States and the European Union are party to the Convention on Biological Diversity.

Future

Living in harmony with nature

Strategic plan 2011-2020

1045 days to Aichi Targets

Biodiversity Targets 2011-2020

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

1045 days to Aichi Targets

Marine species diversity in India

Marine group	No. of species in India	Global estimate
Bacteria	530	4800
Fungi	85	2625
Algae	854	8560
Rhodophyta	434	6200
Acanthocephala	251	621
Annelida	350	20277
Arthropoda	3465	47217
Bryozoa	500	5700
Chaetognatha	30	121
Cnidaria	842	11071
Ctenophora	12	166
Echinodermata	765	6500
Echiura	43	170
Gastrotricha	75	524
Hemichordata	12	115
Mollusca	3370	52525
Nematoda	700	12000
Fishes	2546	25800

Plants

Diatoms 200 species

Dinoflagellates 90 species

Macroalagae 844 species

Sea grasses 14 species

Mangroves 39 species

Biodiversity utilization

Trichodesmium, Noctiluca, Ceratium, Gymnodium, Gonyaulax

-heavy mortality

Sponges

High diversity-485 species

35 are endemic

Biological active compounds

Destruction of sponges by several ways

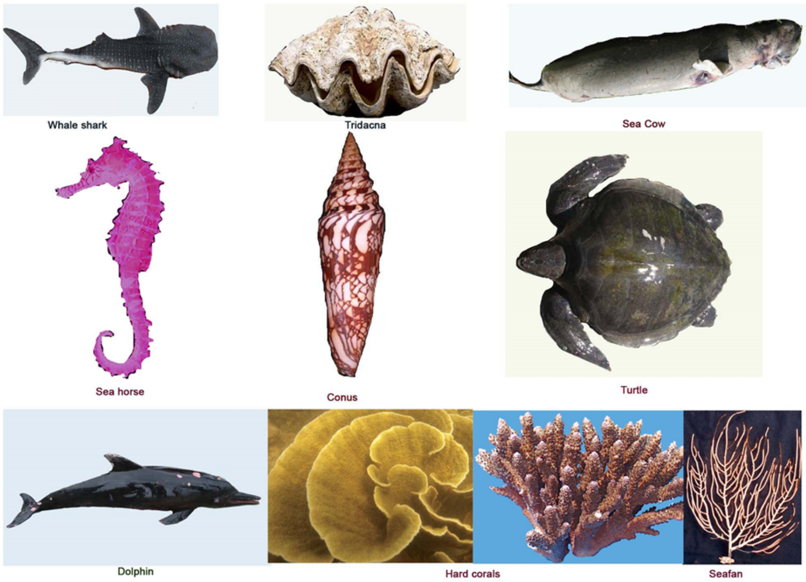
Cnidarians

842 species
Medusae
Soft corals
Hard corals

Wildlife (Protection) Act, 1972 Schedule I

1. Reef building coral (All Scleractinians)
2. Black Coral (All Antipatharians)
3. Organ Pipe Coral (*Tubipora musica*)
4. Fire coral (All Millipora Species)

Protected marine organisms



Crustaceans

3465 species
Crabs -210 species
160 are endemic to India

High diversity

New species, new records

Prawn and lobsters are economically important as the major export item

Spanner crab *Ranina ranina*

Elasmobranchs

- Cartilaginous, largest marine fish species
- Devonian 410 million years ago
- Whale shark (20 m) (largest, filter feeding)
- smallest squaloids and poroscyllids about 20 cm
- Ranges from near shore, pelagic, demersal, column, bottom, oceanic, continental, abyssal
- Solitary and shoaling, predatory, shark eating

LIST OF PROTECTED ELASMOBRANCHS- MOEF

Rhyncodon typus

Carcharhinus hemiodon

Himantura fluviatilis

Anoxypristis cuspidata

Glyphys gangeticus

Urogymnus asperimus

Pristis microdon

Pristis zijsron

Glyphys glyphys

Rhyncobatus djiddensis

Lower chordates

431 species

Urochordates 248

78 endemic

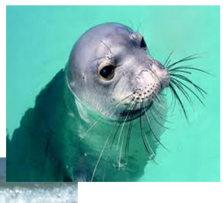
Balanoglossus (*Ptychodera fava*)

Endemic
Ascidians 8 invasive species

Pharmacological products

Reptilia

- Marine reptiles are
  - air-breathing
  - ectothermic
  - poikilothermic vertebrates
- Skin is covered with dry scales and lays their egg on land
- 700 living species only few species of snakes, turtles, and crocodiles are seen in the ocean



Olive Ridley (*Lepidochelys olivacea*)

Leather back (*Dermocheylus olivacea*)

Green Turtle (*Chelonia mydas)*

Logger head (*Caretta caretta*).

Hawksbill (*Eretmocheylus imbricate*)

Squamata (Sea snakes)

- Tropical and sub-tropical waters of Indian Ocean
- Shallow coastal waters, estuary, lakes and fresh water in the rivers.
- Feed on fish, fish eggs, crustacean and tuna
- Genus *Laticauda* is oviparous and all other sea snakes are viviparous
- Sea snake is dangerous is neurotoxic
- Most of the sea snake fisheries in Indian Ocean have not been reported and no data available on it
- 80 species sea snakes in the world oceans and estuaries
- 22 species of marine snakes in India

Marine Mammals

Whales, dolphins, porpoises and dugong are rare and endangered, and are listed under CITES
Migrate to the tropical seas for feeding and breeding and often get entrapped in the tide and washed ashore or entangled in the fishing gears
Globally 130 species were so far recorded
They included in three orders namely
Cetacea (whales, dolphins, and porpoises)

1.Cetacea (whales, dolphins, and porpoises)

2.Sirenia (manatees and dugong)-
- Dugong occur in Gulf of Mannar and Palk bay, Gulf of Kutch, Andaman Islands
  The destruction of sea grass beds due to trawling has further aggravated the situation

3.Carnivora (sea otters, polar bears and pinnipeds like seals and walrus)

Stenella attenuata

Megaptera sp.

Source: Published works

Human component

There are about 4000 costal fishermen villages, nine lakh households and 3.5 million fishermen population in India

What are Wetlands?

- Transitional zones between terrestrial and aquatic systems
- Water table at the surface or land is covered by shallow water.
- Neither truly aquatic nor terrestrial
- Both at the same time depending on seasonality
- Boundaries are often difficult to define
- Dynamics of the water supply, storage, loss is most fundamental

Wetlands are..........

- Millennium ecosystem assessment estimated that wetland covers 7% earths surface delivers 45% worlds natural productivity and ecosystem covers.
- Wetland covers 4% surface delvers more than 55% Ecosystem services covers
- About 50% of earths wetlands are already disappeared over the last 100 years due to **industrial**, **agricultural** and **residential**

Types of Wetlands

- Lakes
- Rivers and streams
- Marshes
- Flood plain
- Mangrove Swamps
- Peat lands
- Estuary
- Shallow ponds
- Tidal flat
- Lagoon

Five wetlands that help us cope with extreme events: 1. Mangroves

- Salt-water tolerant shrubs and trees
- Grow in shallow coastal waters, mostly in tropical, sub-tropical areas
- Roots bind shore, prevent erosion
- Each additional kilometer of mangrove forest can reduce the height of a storm surge by 50cm
- Blunt effect of cyclones/hurricanes and tsunamis
- Carbon-rich tropical forests
- Each hectare worth up to $US 15,161 a year in disaster protection

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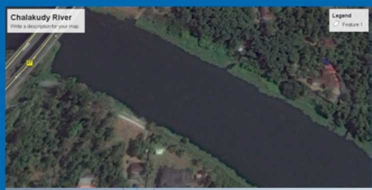
Five wetlands that help us cope with extreme events: 2. Coral reefs

- Solid structures found in shallow tropical waters
  - Formed by living colonies of tiny coral polyps, building on exoskeletons of previous generations
- Home to 25% of all marine species
- Act as important offshore wave and surge barriers
  - Protection worth up to $US 33,556 per hectare/year
- Small investment / huge effect:
  - US$1 million a year on restoring reefs at the Folkestone Marine Park on the west coast of Barbados could lower annual storm losses by US$20 million

Minicoy Island

Five wetlands that help us cope with extreme events: 3. Rivers & flood plains

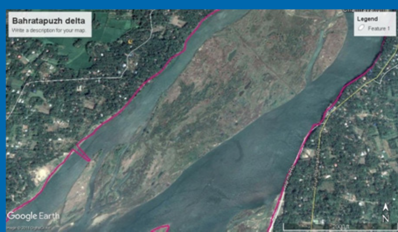
- Rivers and streams meander to create fertile, silted floodplains
- Left intact, along with their network of inland lakes and swamps, they can act as a giant reservoir
- During intense rainfall or sudden floods, they can spread and store water over a wide area
  - Reduce damage downstream
- Many rivers are canalized, especially near cities, eliminating this natural flood control

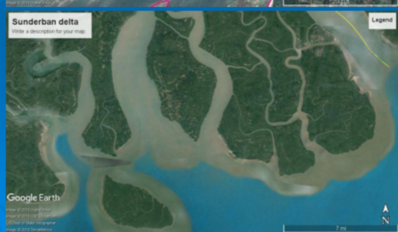


Five wetlands that help us cope with extreme events: 4. Inland deltas

- When water flows into a wide, flat inland lake without draining into the ocean, an inland delta is formed
- In extremely arid areas, these seasonal flows are a strong natural safeguard against drought
- Sunder ban delta

  70% of the Sunder bans is under saline w
  300 species plants, 250 fishes, 300 birds,
  Bengal Tiger, Crocodiles, Fiddler Crab
  Marine Turtles, Dolphins, Sharks,
  Humming birds, Curlews, Jungle fowl





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Five wetlands that help us cope with extreme events: 5. Peatlands

- Water-saturated lands made of decomposed plant material, built up over time
  - up to 30 metres deep
  - also known as mires, bogs or moors
  - cover 3% of the earth's land surface
- Key fact: peatlands store more than *twice* as much carbon as all of the world's forests combined:
  - vital way to mitigate some effects of climate change
  - Pokkkali, Rice cultivation, Kaipad

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Biodiversity valuation

Overview of Economic Valuation Techniques

Direct Use

Provisional service

Regulatory Service

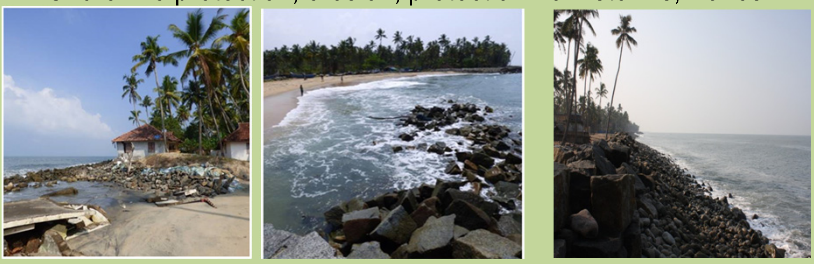
Supporting Service

Overview of Economic Valuation Techniques

Cultural Services

Regulating services

Shore line protection, erosion, protection from storms, waves



Primary production, gaseous exchange, nutrient cycling

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Cultural and recreational services

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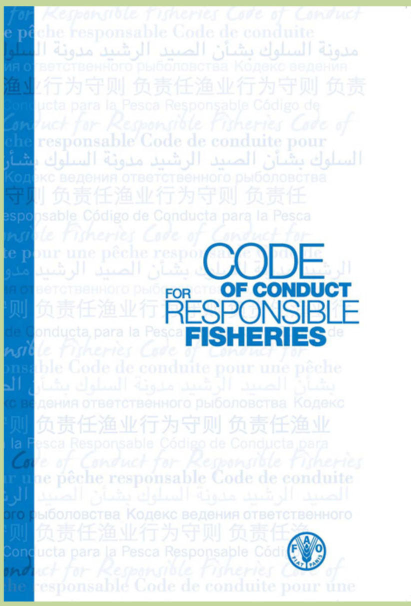
Tools for Mainstreaming

- ❖ **Ecosystem services**
- ❖ **Legal Instruments**
- ❖ **Standard, Codes of conduct, Guidelines and Certificates**
  - ➢ **FAO code of Conduct for Responsible Fisheries**
  - ➢ **Marine Stewardship Council (MSC)**



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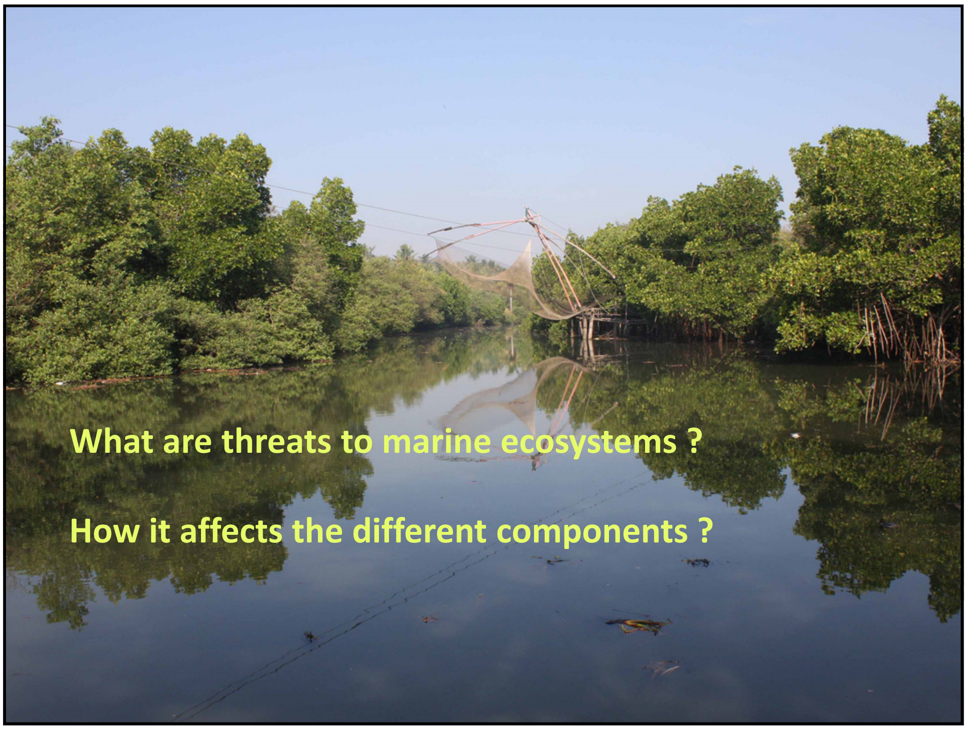
Article 11: Post-harvest practices and trade
Article 12: Fisheries research
Annex 1 : BACKGROUND TO THE ORIGIN AND ELABORATION OF THE CODE

Fishery Diversity- Sustainability



Threats faced by Marine Ecosystem

- Fisheries
- Oil , gas and mining
- Climate change
- Coastal development
- Invasive species
- Pollution
- Tourism

Fisheries

Human population increase in geometrical progression

Fisheries suffers overexploitation

Fish and fishery products provided global population as

a major source of protein for hundreds of years

With latest technologies during the period made fishermen from

a subsistence farmer to a fishermen of large industrial wizard.

From a simple cast nets spanning a few feet to long lines of thousand

Hooks stretch for miles in the ocean

Some of the gears makes targeted species at risk and some make the

Untargeted also in heavy risk

Bottom trawling, cyanide poisoning, blast fishing, electric fishing

Damages marine habitats also

Reduce the species populations and their survival

Unsustainable fishing: 90% of the world's fisheries are already fully exploited or overfished, the catch of juveniles also pose threat to the diversity of fishes. Unsustainable fishing is the largest threat to ocean life and habitats. Untargeted fish catching methods brings about large quantities of fishes and other fauna that leads to loss of the species.

Climate change

Changes in atmospheric condition leads to changes in oceans also
change in sea level, ocean temperature, ocean current system
upwelling
changes in the basic character of the marine ecosystem affects
nutrient cycling, transport of larvae
sustaining the thousands marine life
but millions of human throughout the world

Pollution

- Disastrous oil spills
- Pollutant land runoff
- Debris
- Sewage wastewater
- All waste byproducts of human activities

Pollution: Untreated sewage, garbage, fertilizers, pesticides, industrial chemicals, plastics. Most of the pollutants on land eventually make their way into the ocean, either deliberately dumped there or entering from water run-off and the atmosphere. Not surprisingly, this pollution is harming the entire marine food chain - all the way up to humans.

Tourism and development: Around the world, coastlines have been steadily turned into new housing and tourist developments, and many beaches all but disappear under flocks of holiday-makers each year. This intense human presence is taking its risk on marine life.

Inadequate protection: Oceans cover over 70% of our planet's surface, but only a tiny fraction of the oceans has been protected: just 3.4%. Even worse, the vast majority of the world's few marine parks and reserves are protected in name only. Without more and better managed Marine Protected Areas, the future of the ocean's rich biodiversity - and the local economies it supports - remains uncertain.

Coastal development

More than half of the human population
lives within 60 km of Coastline

Costal area experiences heavy pressure which was never before
Development, habitat alteration and destruction

Invasive species

Flow of products during international trade and travel may carry more than its intended cargo

Traffic of people and products may bring unwanted guest

Invasive species may cause imbalance and deteriorate environment

Endanger the survival of the endemic and threatened species

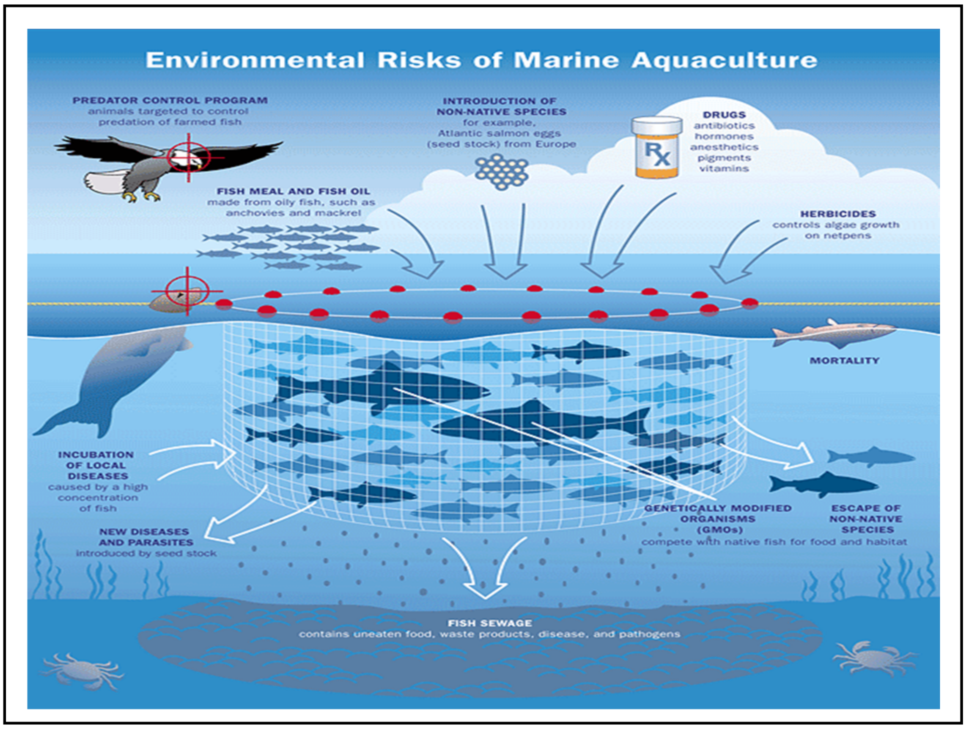
Tourism

Oil, gas and mining

Human dependence on fossil fuel leads to damage of marine biodiversity

Mining for natural resources leads to ecosystem damage

Seismic explorations, equipment construction, waste disposal affects bottom fauna, loss of habitat, water quality



Environmental Risks of Marine Aquaculture
PREDATOR CONTROL PROGRAM
animals targeted to control predation of farmed fish
INTRODUCTION OF NON-NATIVE SPECIES
for example, Atlantic salmon eggs (seed stock) from Europe
DRUGS
antibiotics
hormones
anesthetics
pigments
vitamins
FISH MEAL AND FISH OIL
made from oily fish, such as anchovies and mackrel
HERBICIDES
controls algae growth on netpens
MORTALITY
INCUBATION OF LOCAL DISEASES
caused by a high concentration of fish
NEW DISEASES AND PARASITES
introduced by seed stock
GENETICALLY MODIFIED ORGANISMS (GMOs)
ESCAPE OF NON-NATIVE SPECIES
compete with native fish for food and habitat
FISH SEWAGE
contains uneaten food, waste products, disease, and pathogens

Thank you

ENVIRONMENTAL VARIATIONS AND IMPACTS ON FISH BIOLOGY: NEW THREATS TO AQUATIC SUSTAINABILITY

Dr V.Kripa
Principal Scientist & Head i/c
Fishery Environment Management Division
Central Marine Fisheries Research Institute, Kochi

Session –Fishery Biology, Toxicology, Environment

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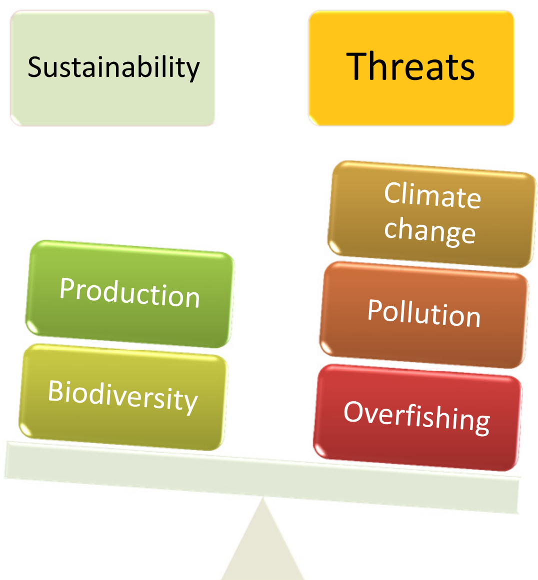


Dr.V.KRIPA Principal Scientist CMFRI

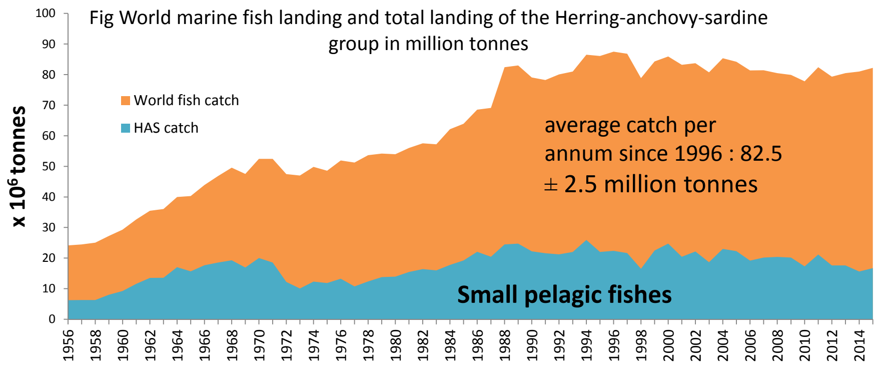
2

1

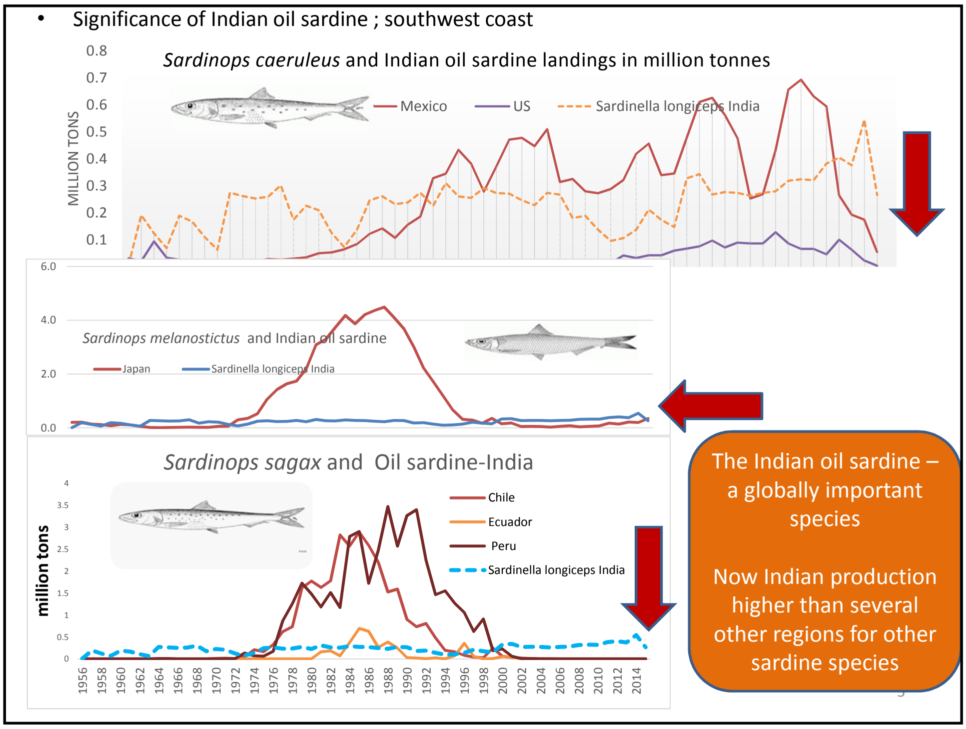
Impacts on small pelagics –Case study of Indian oil sardine collapse

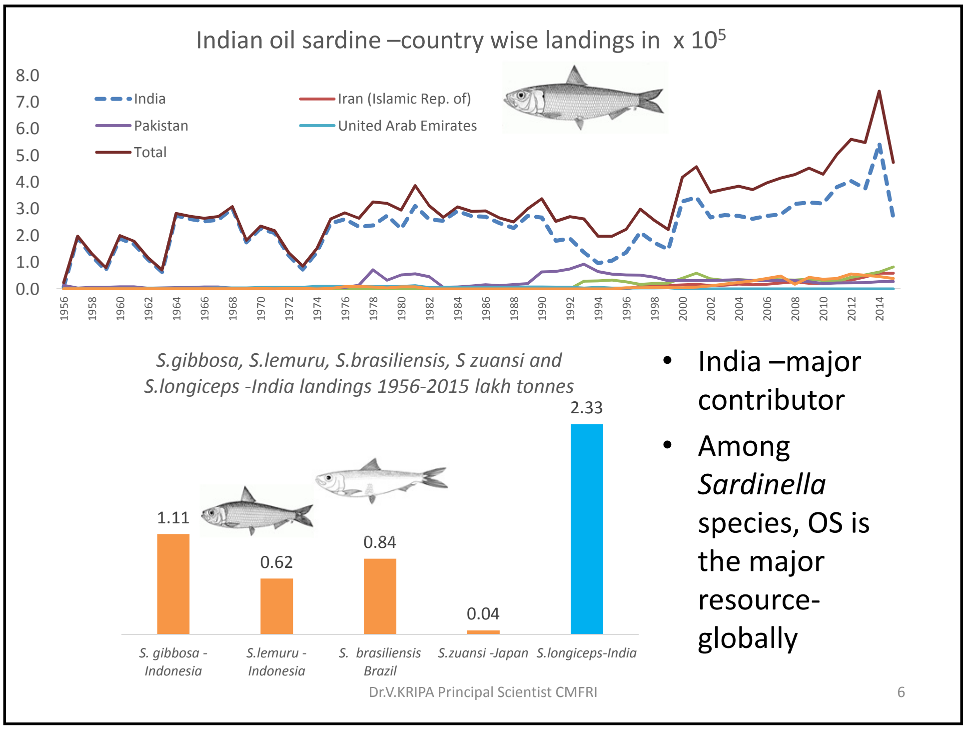
CHANGING SEASONS AND MORE FREQUENT EPISODES OF EXTREME EVENTS (CLIMATE THREAT)

Significance of small pelagic fishes



Small pelagic fishes : Herrings, Anchovies and Sardine (HAS) in FAO contributed to world fish landings highest - **42.7 %** of the world marine fish production in 1964 lowest **19%** in 2014.
large fluctuations in abundance related either to environmental variations or due to fishing or a combination of both.


• Significance of Indian oil sardine ; southwest coast
Sardinops caeruleus and Indian oil sardine landings in million tonnes
MILLION TONS
Mexico
US
Sardinella longiceps India
Sardinops melanostictus and Indian oil sardine
Japan
Sardinella longiceps India
Sardinops sagax and Oil sardine-India
million tons
Chile
Ecuador
Peru
Sardinella longiceps India
The Indian oil sardine – a globally important species
Now Indian production higher than several other regions for other sardine species


Indian oil sardine –country wise landings in x 10⁵
India
Pakistan
Total
Iran (Islamic Rep. of)
United Arab Emirates
S.gibbosa, S.lemuru, S.brasiliensis, S zuansi and S.longiceps -India landings 1956-2015 lakh tonnes
1.11
0.62
0.84
0.04
2.33
S. gibbosa - Indonesia
S.lemuru - Indonesia
S. brasiliensis Brazil
S.zuansi -Japan
S.longiceps-India
• India –major contributor
• Among Sardinella species, OS is the major resource-globally
Dr.V.KRIPA Principal Scientist CMFRI
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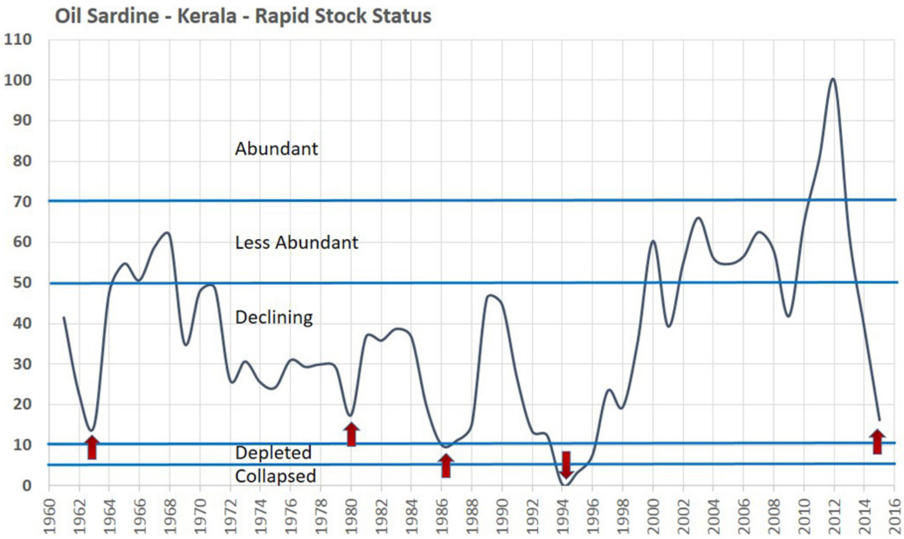
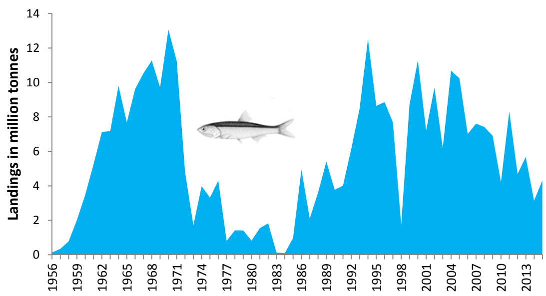
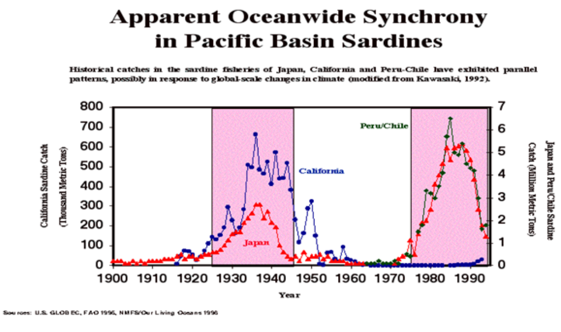
Sardine fishery collapse -2015-2016

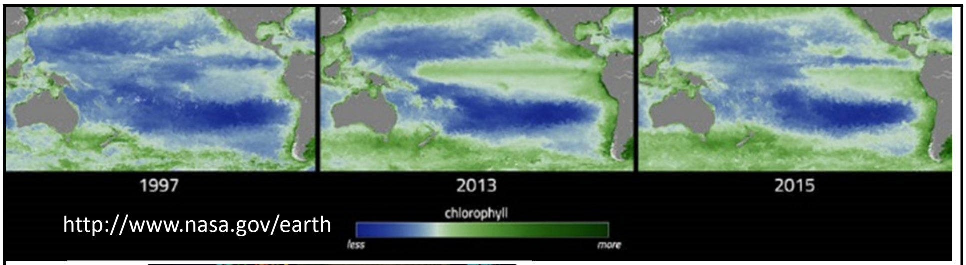


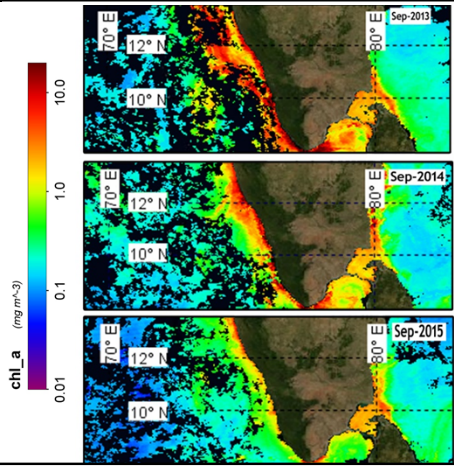
El Nino and Peruvian anchovy *Engraulis ringens*





- huge schools within 80 km, longevity3 years, reaching 20 cm Lm at about one year age and 10 cm
- 13.1 million tonnes in 1971; severely impacted by
- El Niño of 1982–1983, the 1997–1998 El Niño
- **In October 2015**, an El Niño year, of **3.38** mmt was estimated surveyed by The Peruvian Marine Research Institute, only 2 million metric tons were of reproductive age; 5 million metric tons are needed to open fisheries,

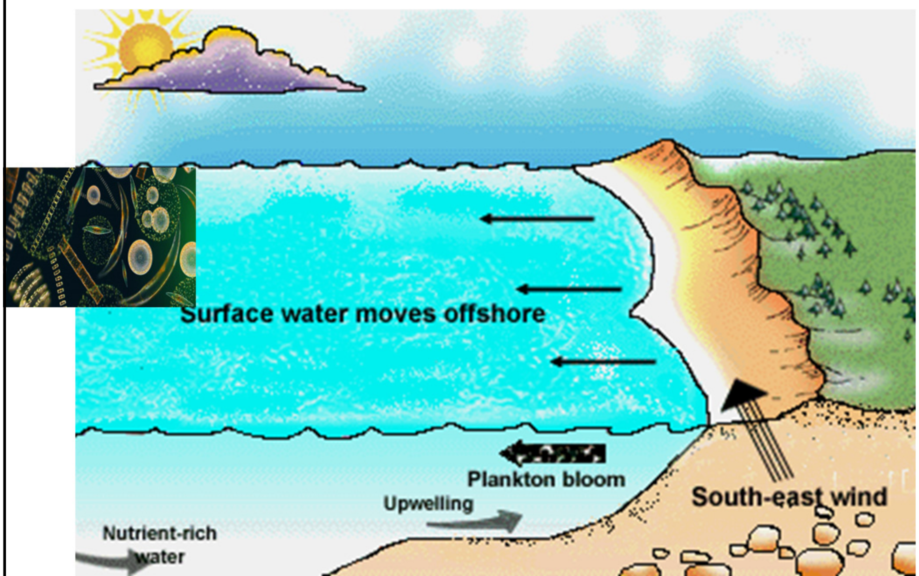


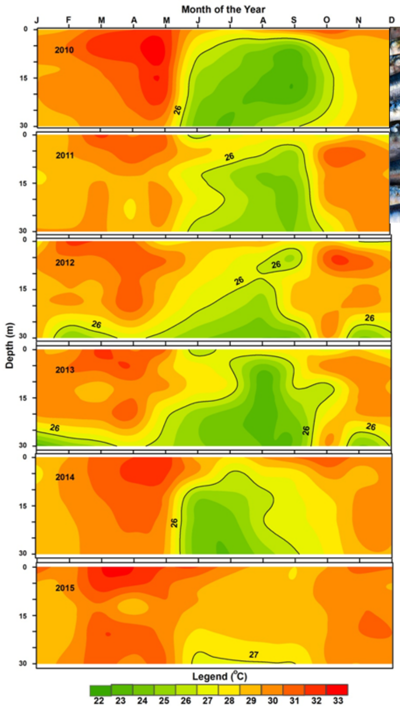


DROUGHT LIKE SITUATION IN THE SEA

Sardine failed to mature
Poor recruitment
Spawning biomass declined

tist CMFRI 9



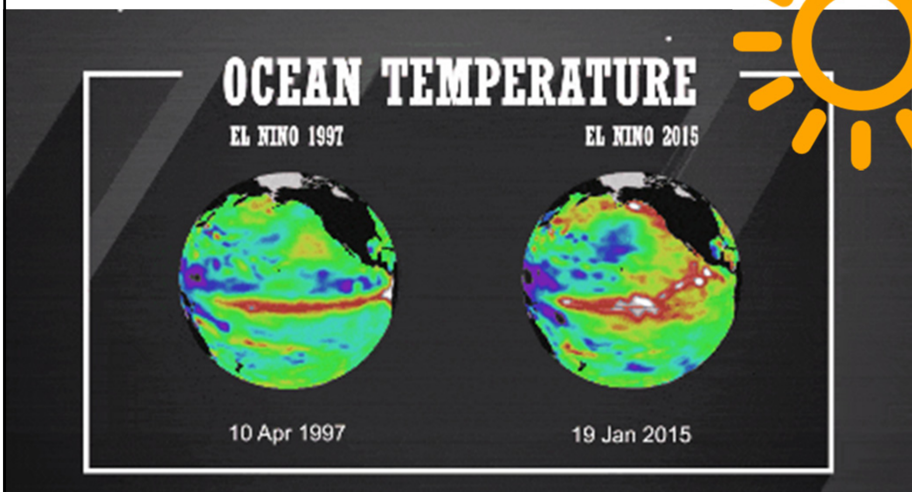


Upwelling -

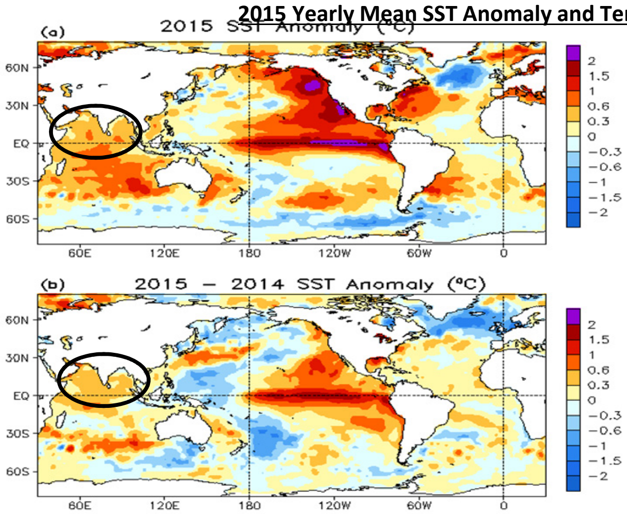
Temperature variation in sardine habitat. The average seawater temperature in sardine habitat **was 29.8 deg C** during 2015, which is nearly 1.1 deg C higher than the avg observed (28.6 deg C) for the last 5 years

line analysis CMFRI 2016 11

2015



2015 Yearly Mean SST Anomaly and Tendency



- Positive **SSTA exceeding 0.6°C** dominated in the tropical Indian Ocean.

- There was a substantial warming in the tropical Indian Ocean, **partially due to influences of the 2015 El Nino.**

Global SST Section in the BAMS State of the Climate in 2015 by Xue et al.

Fig. 3.1. (a) Yearly mean OISST anomaly (°C, relative to 1981-2010 average) in 2015, (b) 2015 minus 2014 OISST anomaly.

http://www.cpc.ncep.noaa.gov/products/GODAS/

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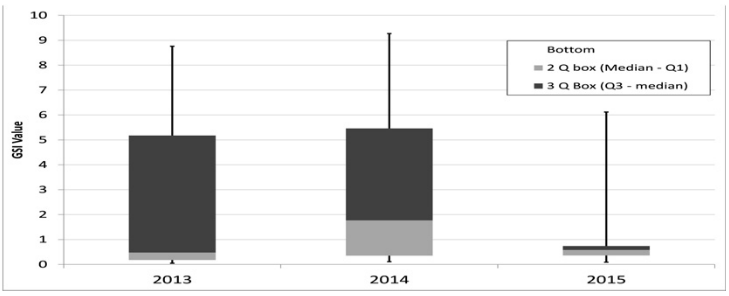
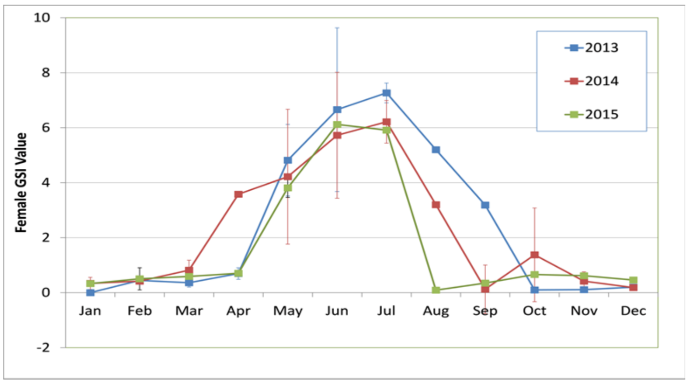
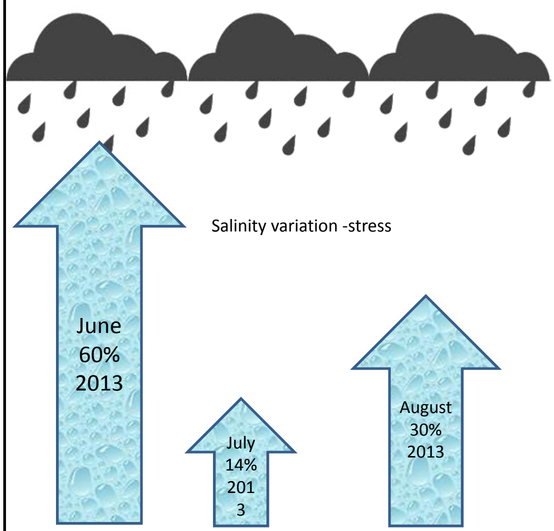
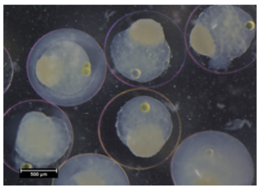




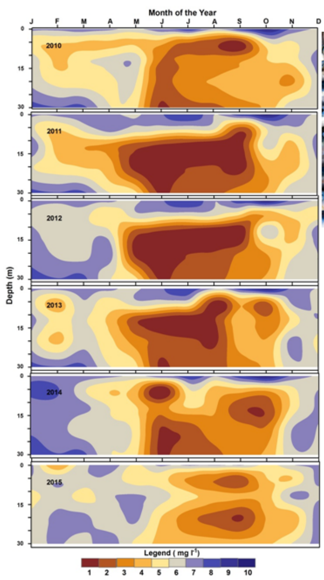


Salinity variation -stress



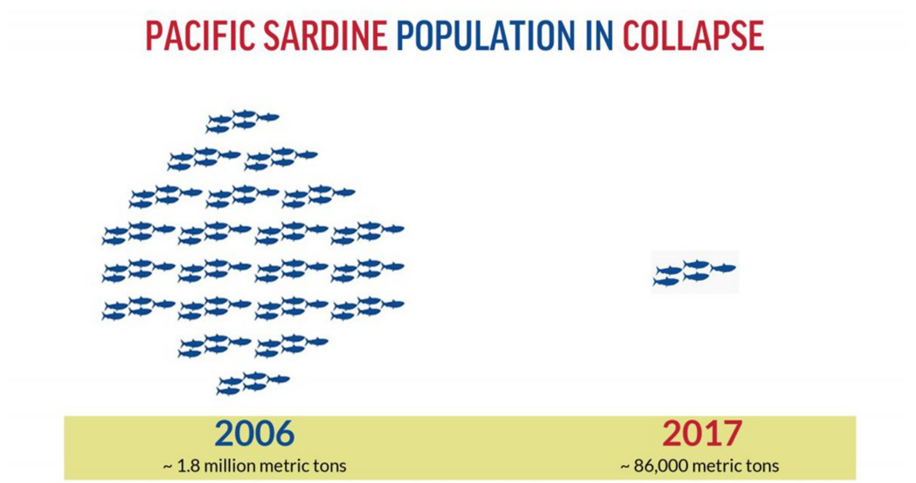
2013 Very low salinity

Hypoxic condition extending from near shore area up to 20 to 30 m depth

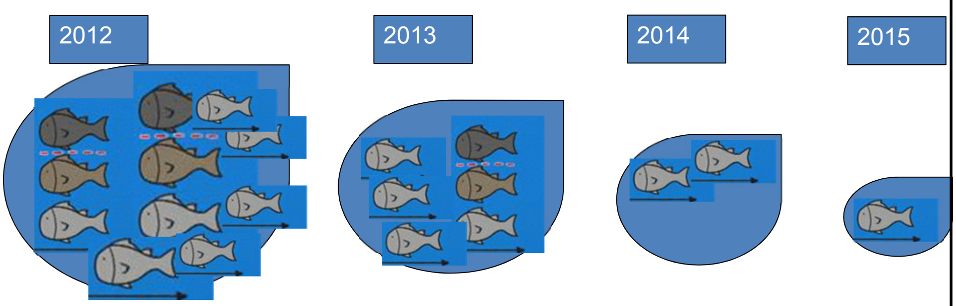


Second upwelling

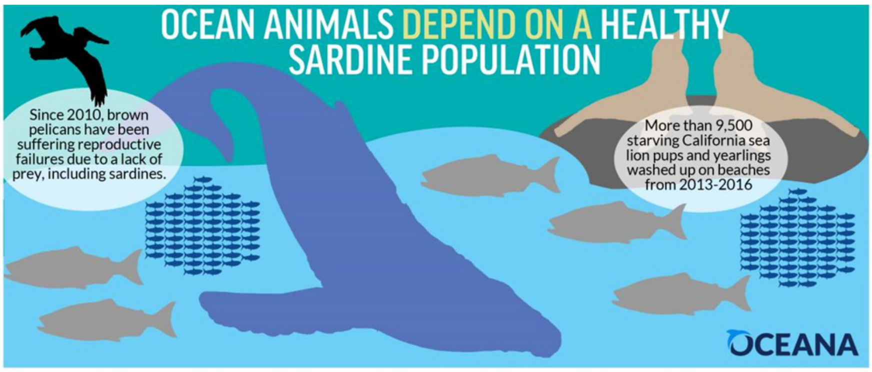
- Negative aspect of upwelling is low oxygen condition which can lead to "stressed environment" and lead to **avoidance** of the area. The intensity of hypoxia has been found to vary



Decrease in spawning population from 2012 to 2016



Cascading effect in the trophic chain



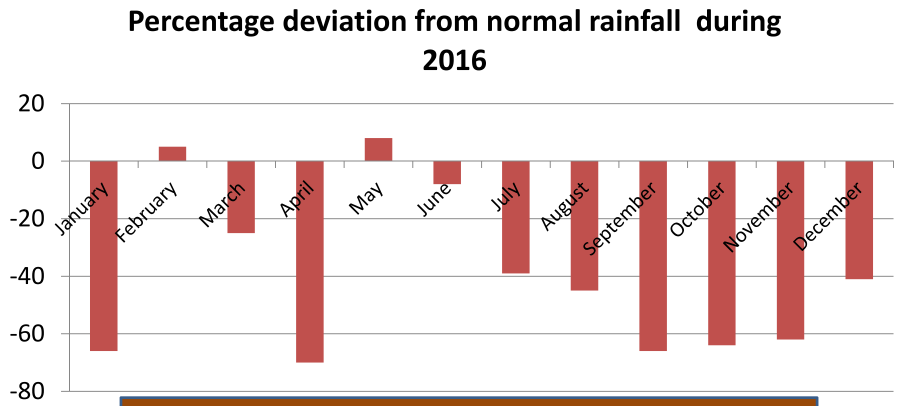
Fleshfooted Shearwater flock feeds Oil sardine *Sardinella longiceps during 2014*

The way forward

Present	What can be done
• Only limited fisheries management programs and governance • No preparedness to face fishery collapses • MLS implemented in Kerala; but yet to be implemented in other states	• Very effective FMP (especially good governance) in all maritime states • Effective predictions to be developed on climatic factors and eggs and larval studies • International research collaborations for capacity building on these themes • Develop schemes to financially support small scale fishers during fish biomass decline due to natural calamities like in agriculture

Impacts of extreme events on other resources

2016-Rainfall- deficit year



Extremely low rainfall-----led to poor water flow, river discharges
Affected planton production and even intrusion of jellyfishes in estuaries during March April it self...threat to estuarine fauna recruitment

Jelly fishes in backwaters

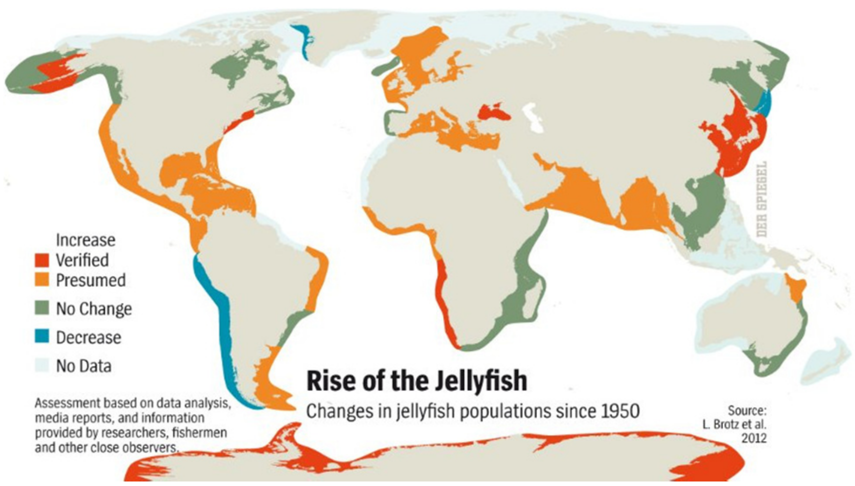
- Usually seen during peak summer, but now even during late post monsoon
- A threat to fish larvae
- low fish catch, economic loss
- Menace to farmers

2

Jelly fish blooms in coastal /inshore fishing areas

JELLY FISH MENACE

Changes in jellyfish populations



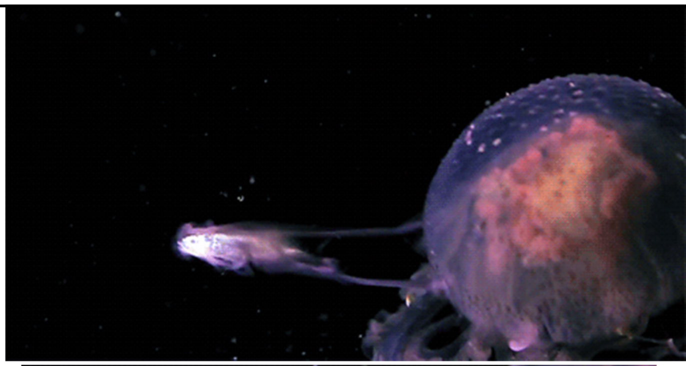
A global regime shift from a **fish to a jellyfish ocean**

Why blooms occur

- **Ecological imbalance** due to removal of top predators
- **Eutrophication** of coastal waters due to urbanization
- **low oxygen**
- **New structure** where polps can attach

What happens during blooms

- **Endanger fish stocks** : high impact on fish eggs and larvae, either directly or by competing for the same food sources
- Further **reduce resilience** of already affected fish stocks



How jellyfish blooms affect fish resources

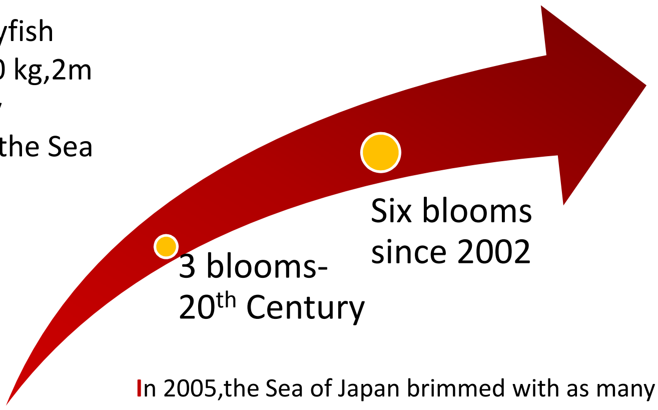
- Salmon production vs *Chrysaora fuscescens*, off the Pacific Northwest coast.
- There was a significant, negative correlation between jellyfish biomass and the **strength of adult salmon returning to the Columbia River**
- **Low feeding** : feeding incidence showed that salmon stomachs were less full at locations with higher sea nettle biomass.

Ref : Evidence that summer jellyfish blooms impact Pacific Northwest salmon production et al.,Ecosphere 2016 DOI: 10.1002/ecs2.1324

•James J. Ruzicka

Seas of Japan under jellyfish threat

Nomura's jellyfish (weighing 220 kg,2m dia was rarely encountered the Sea of Japan.



In 2005,the Sea of Japan brimmed with as many as 20 billion jellyfishes …….. In fisheries, 30 billion yen was estimated as loss

Jelly fishes in inshore waters this year also

ISSN 1198-672

Fisheries Centre Research Reports
2011 Volume 19 Number 5

CHANGING JELLYFISH POPULATIONS: TRENDS IN LARGE MARINE ECOSYSTEMS

Jellyfish blooms creating oceans of slime

In the last decade enormous plagues of jellyfish have been taking over the seas. And it is our fault.

By Gaia Vince
5 April 2012

THE HINDU

THIRUVANANTHAPURAM
Jellyfish blooms pose threat to State

T. Nandakumar

After brief lull, jellyfish blooms resurface along N Goa coastline

Paul Fernandes | TNN | Updated: Nov 6, 2016, 02.34 PM IST

(Representative image)

RI

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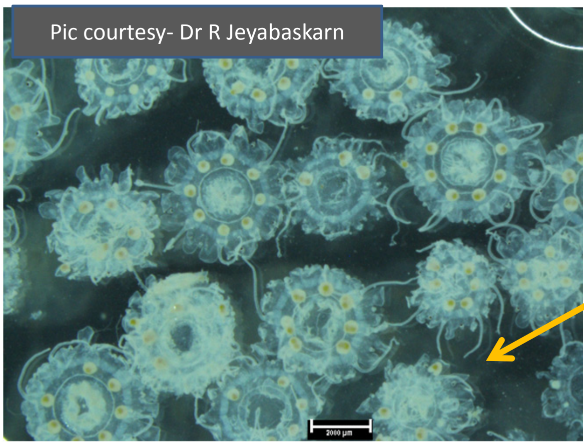
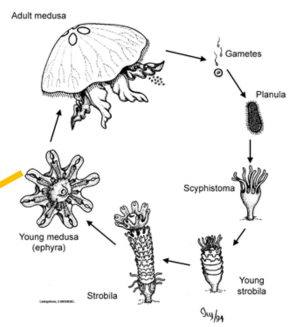
Ephyrae of *Chrysaura* sp.

First Report on Ephyrae





The ephyrae of the jellyfish *Chrysaura* sp was identified on 22.5.2015; just 2 months before the bloom. Bloom observed on end of July, 2015

TROPHIC CONTROL

- In East China Sea -Forty-five functional groups were defined in the model including 32 fish (19 single species and 10 multispecies.
- The average trophic level of fishery catch was 2.71 while the mean value for all groups was 2.87.
- Study indicated trophic mutual competition and predation between large jellyfish and Stromateoidae. So utilize this information for ecosystem based management

Trophic controls of jellyfish blooms and links with fisheries in the East China Sea Jiang Honga et al ecological modelling 212 (2008) 492–503

The way forward

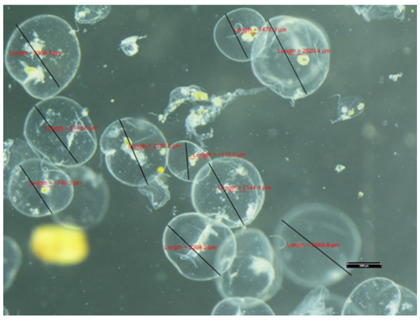
- Include jellyfish research into fisheries research.
- Develop early warning systems for bloom forming species
- Utilize jelly fish in (in collagen preparations; treat rheumatoid arthritis eg), have rich biomedical properties
- As food- dried and chopped into noodle-like strips to be added to soups, entrepreneurial Japanese are even making vanilla-and-jellyfish ice cream.
- 80% protein and very low in fat, although the high sodium content probably outweighs their health benefits.
- Reduce eutrophication through proper control measures

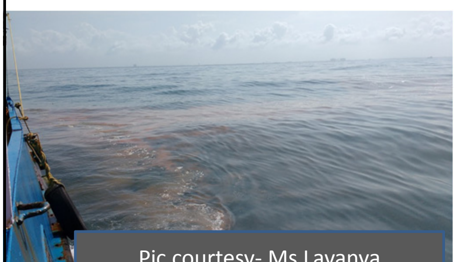
3

Anthropogenic impacts

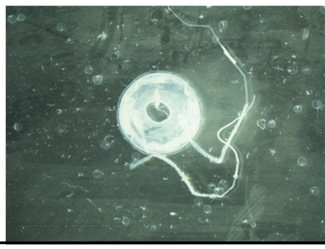
HARMFUL ALGAL BLOOMS

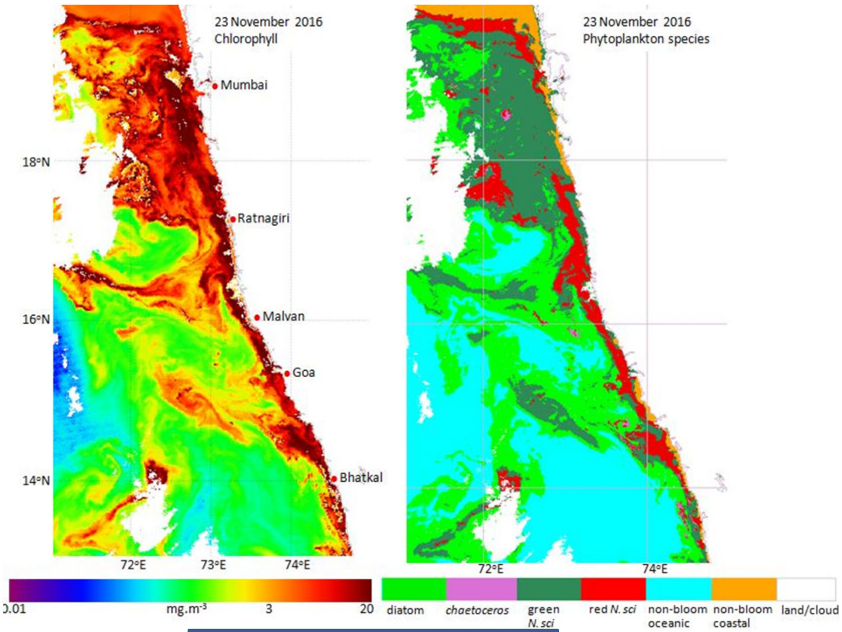
Noctiluca scintillans blooms



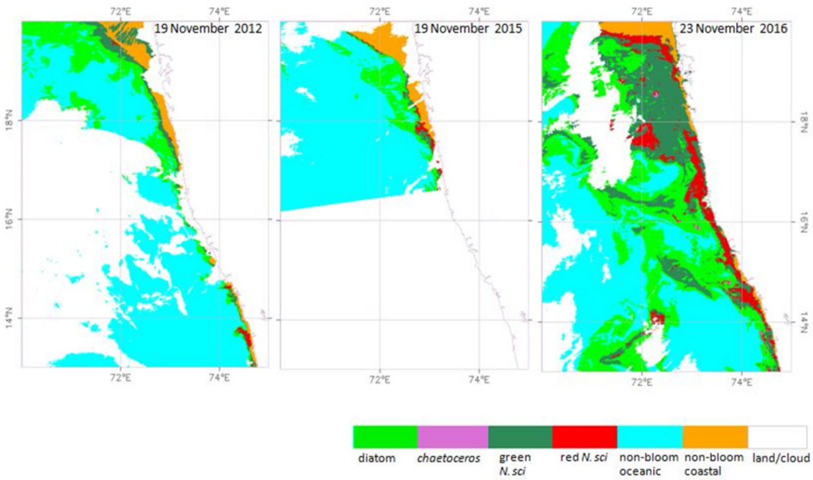


Pic courtesy- Ms Lavanya





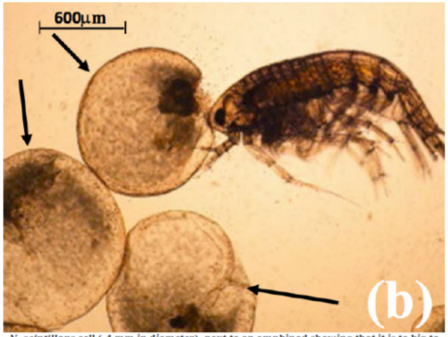
Pic courtesy- Dr Dwivedi



The HAB menace

The issue

- Complete disruption of normal food chain

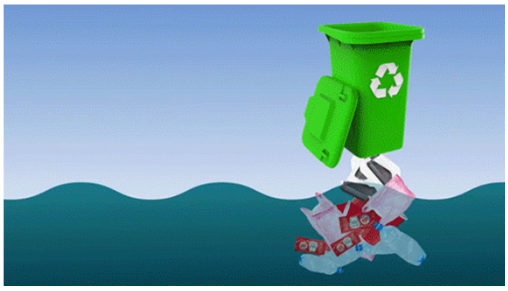


N. scintillans cell (~1 mm in diameter), next to an amphipod showing that it is to big to be eaten by a similar sized zooplankton.
Image: SGP Matondkar

Way forward

- Develop prediction and early warning systems
- More important ---reduce eutrophication and coastal pollution which promote such HABs

4



Anthropogenic impacts

LITTER IN AQUATIC SYSTEMS

4.8 and 12.7 million MT enter the oceans.

The UNEP has recently initiated a special program ***'Global Initiative on Marine Litter'***. Three main industries which are affected by **marine debris are fisheries, shipping and tourism** and the estimated damage to these sectors in **APEC region is US$1.265 million annually**.

Annual production is about 50,000 tonnes

Some of the poorest fishers of India

Decrease in bivalve population can affect ecology of the whole system

Benthic habitat

- Flat fish habitat
- Egg laying habitat of gastropods, octopuses and fishes

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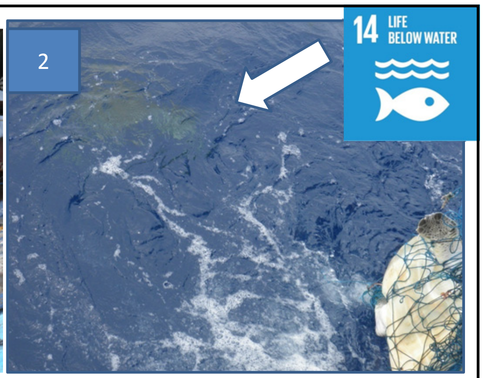


Views of two turtles which were entangled in derelict fishing gear in Arabian sea.

1) the two were pulled near the vessel
2) one turtle freed by cutting the net
3) the second turtle also to be made free

Photographs by CMFRI crew on board an experimental fishing vessel in Arabian sea during April 2012

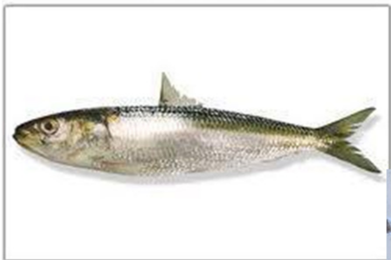
Danger—chemicals leaching from plastics

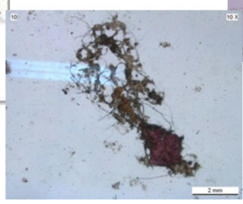
The **fragmentation of plastics increases** leaching of these chemicals and enable more surface area for adsorption of toxic chemicals from environment

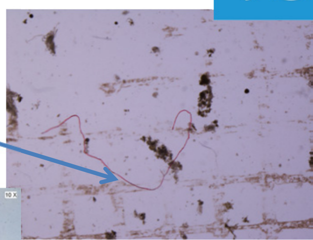
- The toxicity of additive chemicals (default in manufacture) eg: **phthalates** (endocrine disrupting and carcinogenic), **bisphenol A** (endocrine disruption and cytotoxicity), **brominated flame** retardants (immunotoxicity, cytotoxicity, neurotoxicity, endocrine disruption), **triclosan, bisphenone** and **organotins** which can leach from the polymer into the surroundings as the bond weakly with the polymer.

Micro-plastic contamination in fish

Indian Oil Sardine

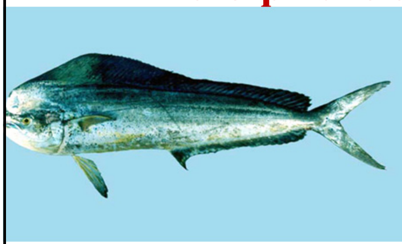






The abundance of MPs recorded from the sediment samples is in the range of 96–496 particles m^{-2} with a mean abundance of 252.80 ± 25.76 particles m^{-2}.

Macro-plastic contamination in fish



Pic courtesy- Dr Bindu Sulochanan CMFRI

Pic courtesy- Dr VV Singh/Mumbai RC CMFRI

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Way forward

1. Awareness campaigns----student blue/green brigades
2. Collection Mechanism
3. Segregation
4. Efficient Transportation
5. Treatment facilities
6. For fishermen -Incentives – for litter reduction
7. Implementation of Rules and regulations

The way forward

14 LIFE BELOW WATER

- CRZ – not targeting marine litter
- The Ministry of Environment and Forest (MoEF) has issued MSW management and handling rules for scientific MSWM –but this has not targeted marine debris.
- Hence –there should be a

National Marine Debris Management Strategy

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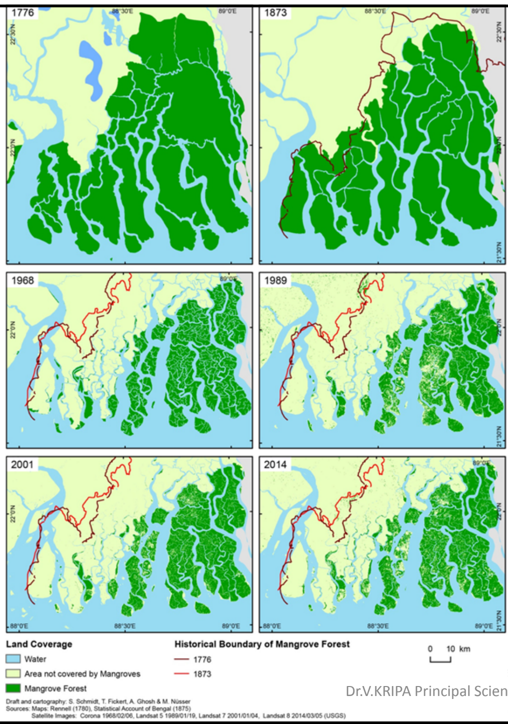
Anthropogenic impacts

HABITAT ALTERATION



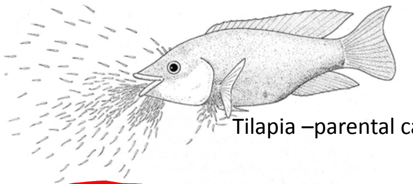
- policies may be designed, employing instruments such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation) and the CDM (Clean Development Mechanism)

Ghosh Susanne Schmidt , Thomas Fickert and Marcus Nüsser

ity **2015**, *7*(2), 149-169; doi:10.3390/d7020149

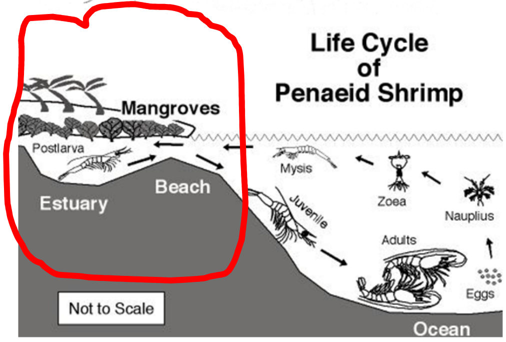
dian Sundarban Mangrove Forests: History, Utilization, rvation Strategies and Local Perception

Important breeding ground and nursery of valuable biota



Tilapia –parental care

Karimeen-Pearl spot



Eggs of Pearl spot

Many species have already become extinct, particularly in **tropical** areas. This loss of biodiversity impacts food resources, such as fish stocks

In Canada

- 625 Canadian scientists signed a letter protesting 2012 changes to the Fisheries Act stating: Habitat destruction is the most common reason for species decline
- NO HABITAT, NO FISH, THE SCIENCE IS CLEAR

What can be done in India

- Clear enforceable habitat protection provisions will help protect fish and fisheries

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14 LIFE BELOW WATER

Oil and Grease

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Global crude oil flows

- 2nd LARGEST CONSUMER IN ASIA-PACIFIC REGION
- 70% OF WORLD OIL DEMAND FERRIED ALONG INDIAN COASTLINE
- INDIGENOUS PRODUCTION ≈35 MMTPA
- IMPORT ≈200 MMPTA

Credit : Former DIG ANISH A HEBBAR, TM

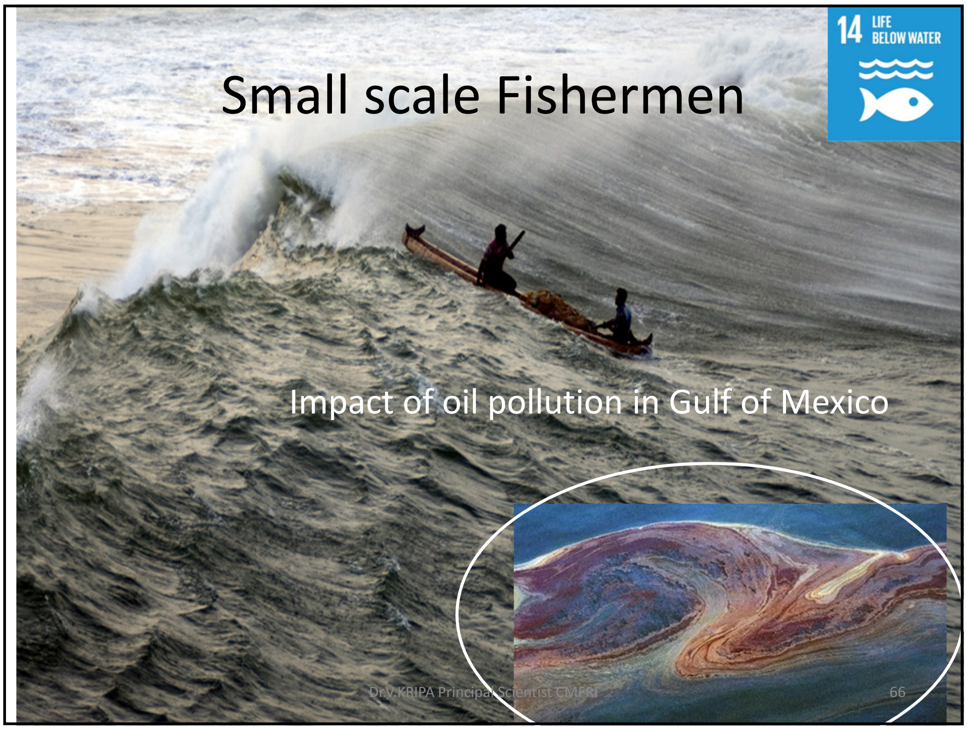
MSC Chitra

- Collision on 07 Aug 2010
- Off Mumbai
- 800 tons

MSC Chitra

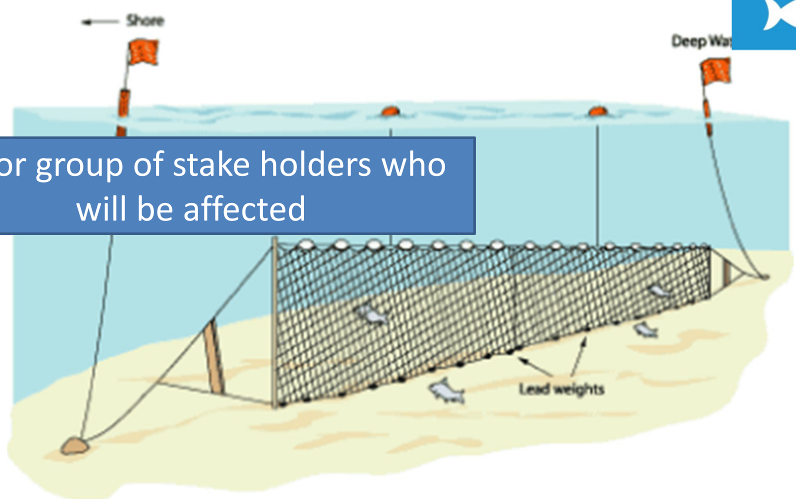
- Affected 33 Fishing villages in 3 districts
- **Prohibition on landing of contaminated fish by Mumbai Municipal Corporation**
- Fishing effort by mechanized vessels for August 2010 decreased by 29% and landings declined by 6% while the non-mechanized fishing recorded 49% decline in landings
- 60 fish markets across Mumbai empty for the week consequent to the spill
- Fisheries loss rupees 60-80 crore
- Fish from other states not allowed to enter Mumbai
- Stocked frozen fish sold at low price to clear the stock

Small scale Fishermen



Gill netters

Major group of stake holders who will be affected



Bottom-dwelling fish

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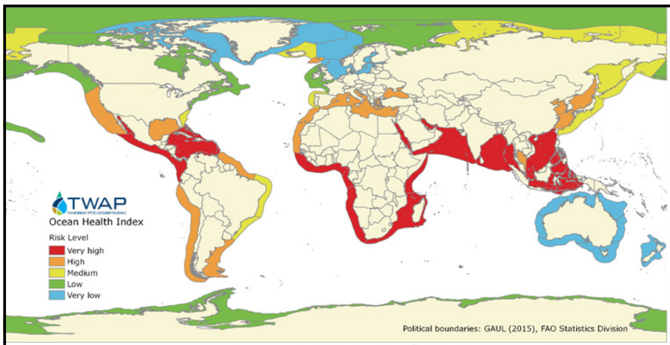
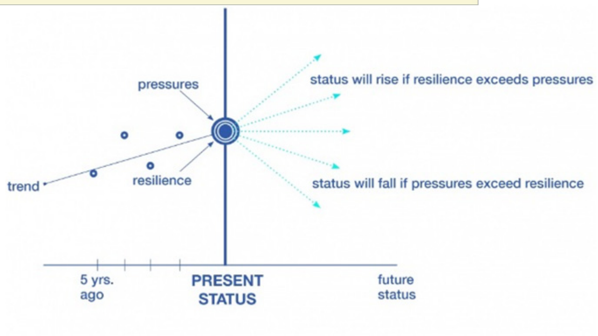
The way forward

- **Spatial Maps** of critical habitats along the Indian coasts and the route of oil tankers.-So that precaution can be taken
- **Map of vulnerable resource** abundance and make it available to oil tankers
- More research on the **impacts** of resources and ecosystem
- How plankton and benthos are affected

To conclude……

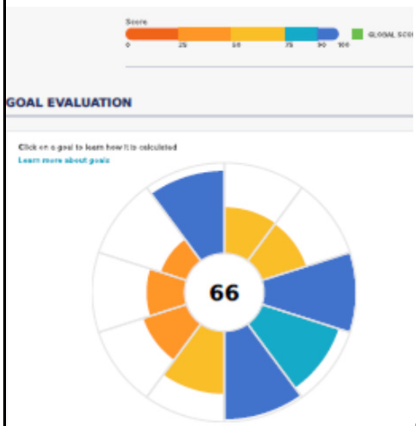


OCEAN HEALTH INDEX



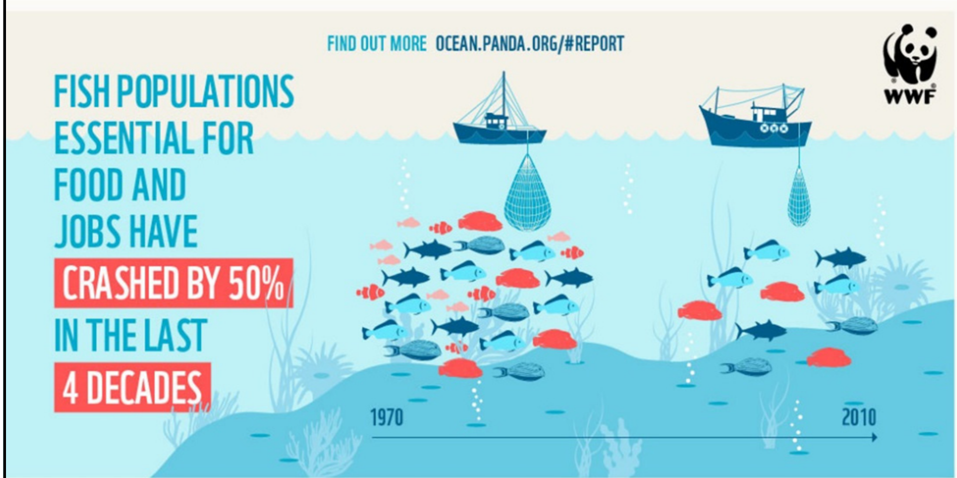
Ocean Health Index –India 2016

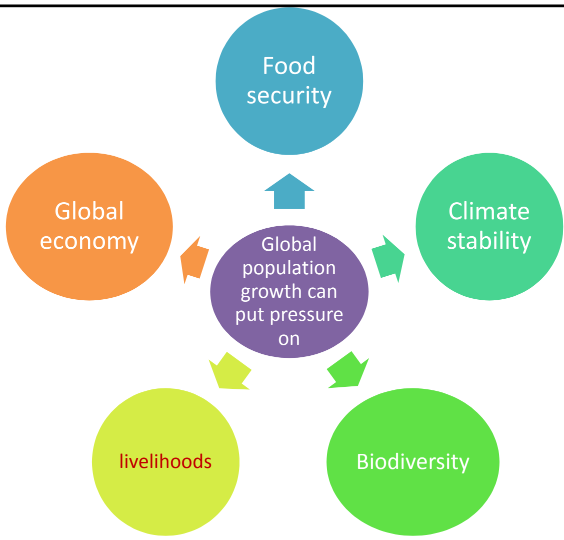
Score 66; 130th rank
out of 221 EEZ



Score	Parameter
51	Food provision
50	Artisanal fishing opportunity
99	Natural products
87	Carbon storage
97	Coastal protection
69	Coastal livelihoods and economy
49	Tourism and recreation
41	Sense of place
29	Clean waters
91	Biodiversity
66.3	

There should be good FMP and governance





So…the way forward : Each nation should chart out specific plans to improve their OHI